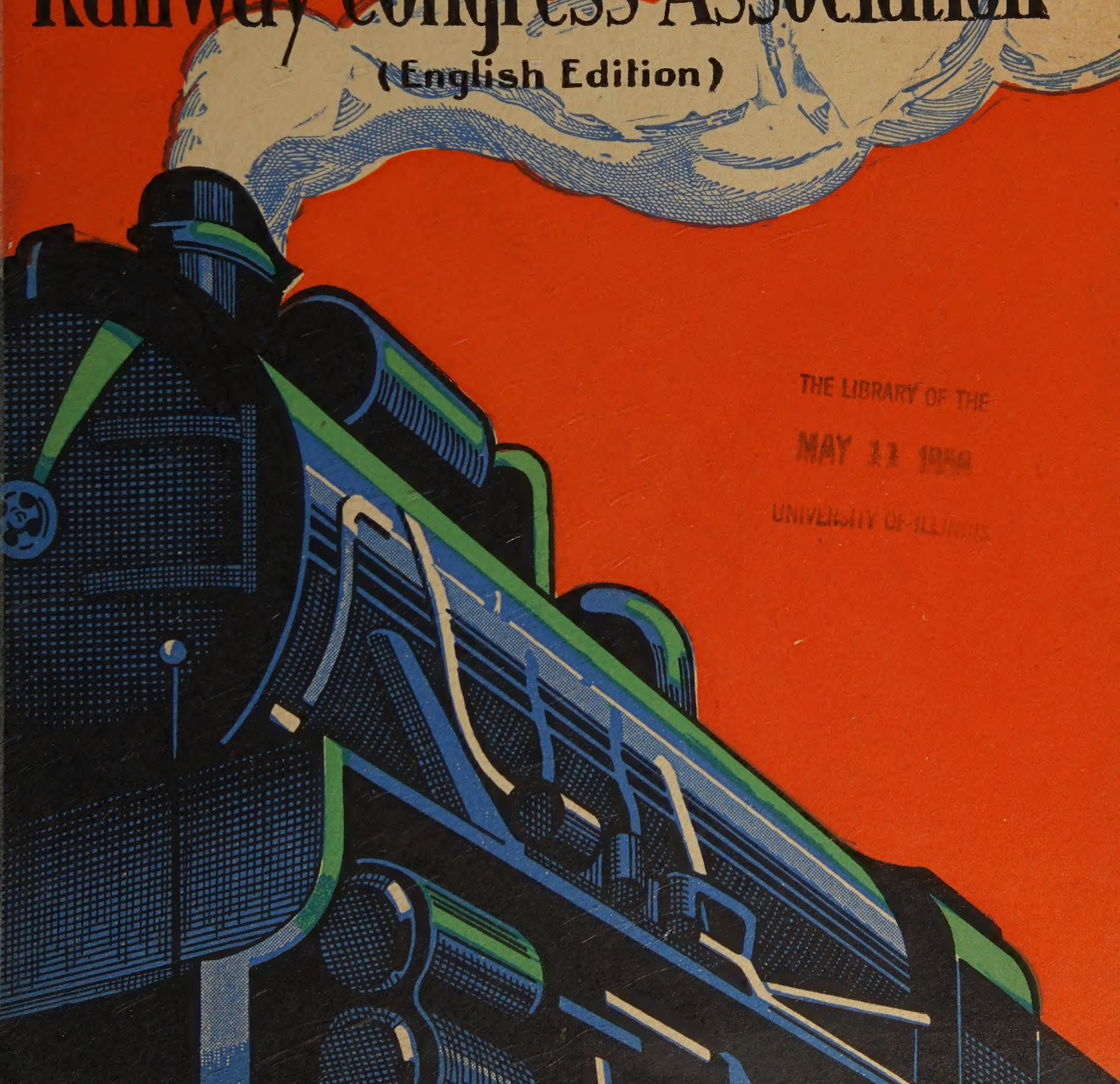
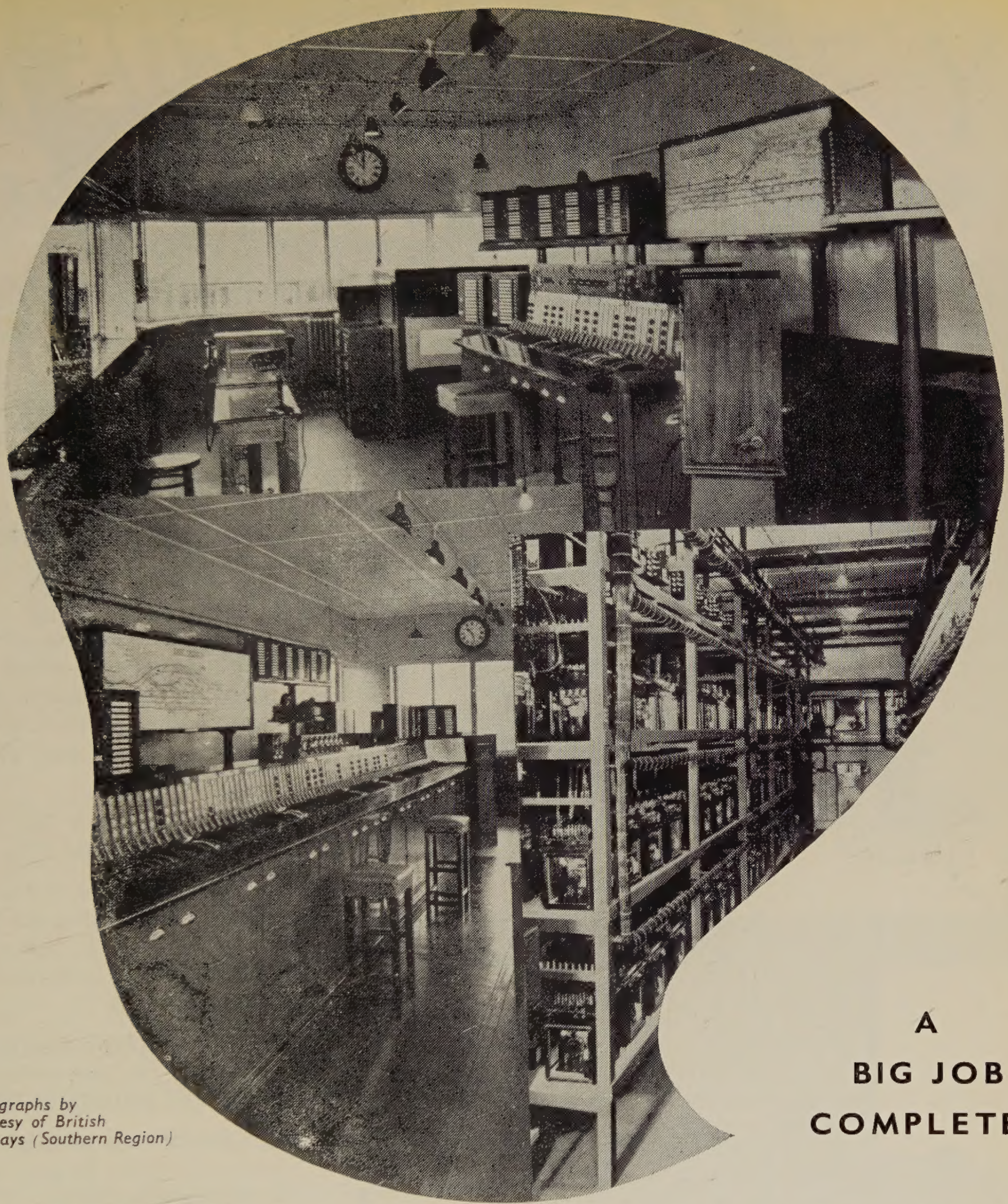
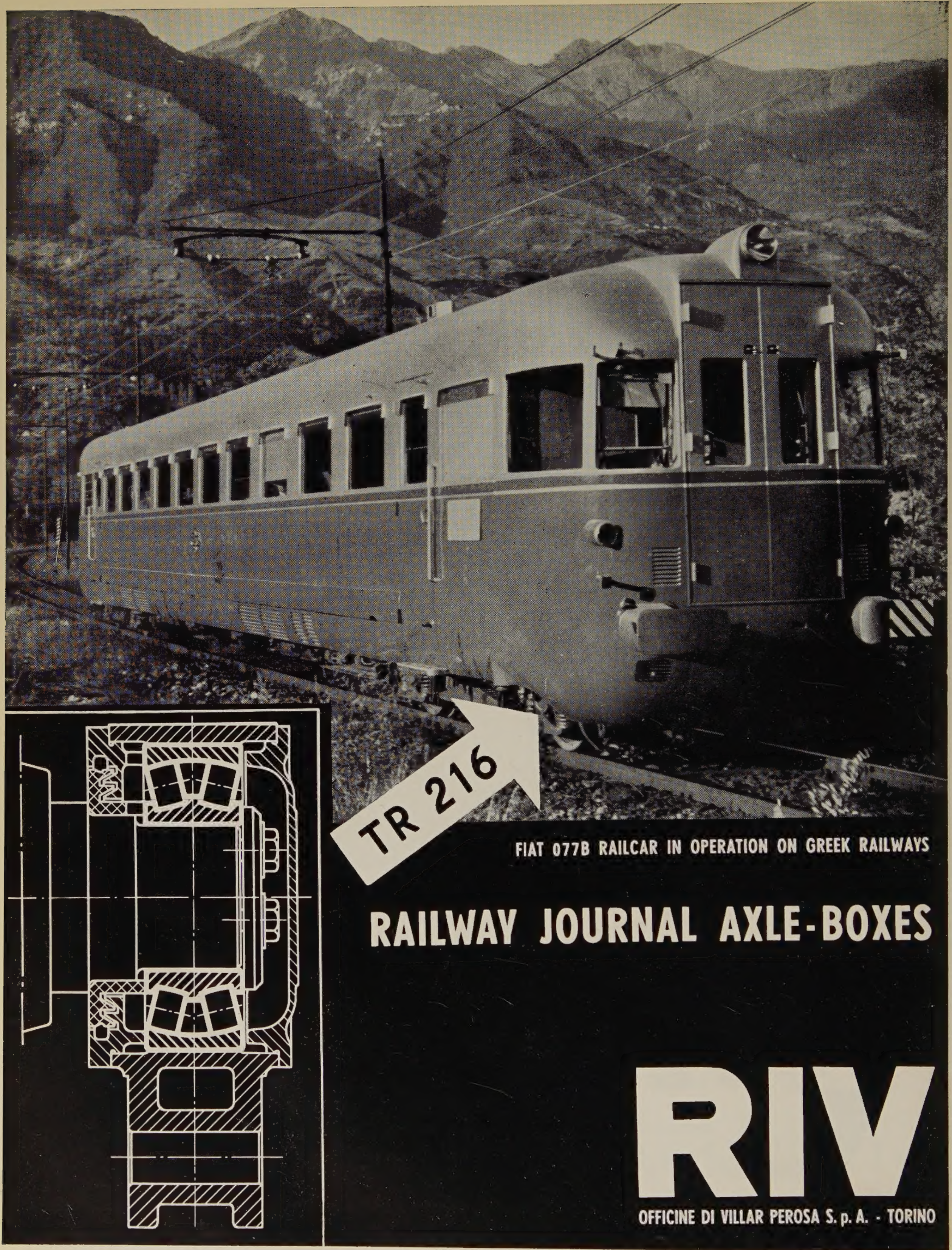
VOL. XXXIII. — No. 4. APRIL 1956

Monthly Bulletin of the International Railway Congress Association

(English Edition)



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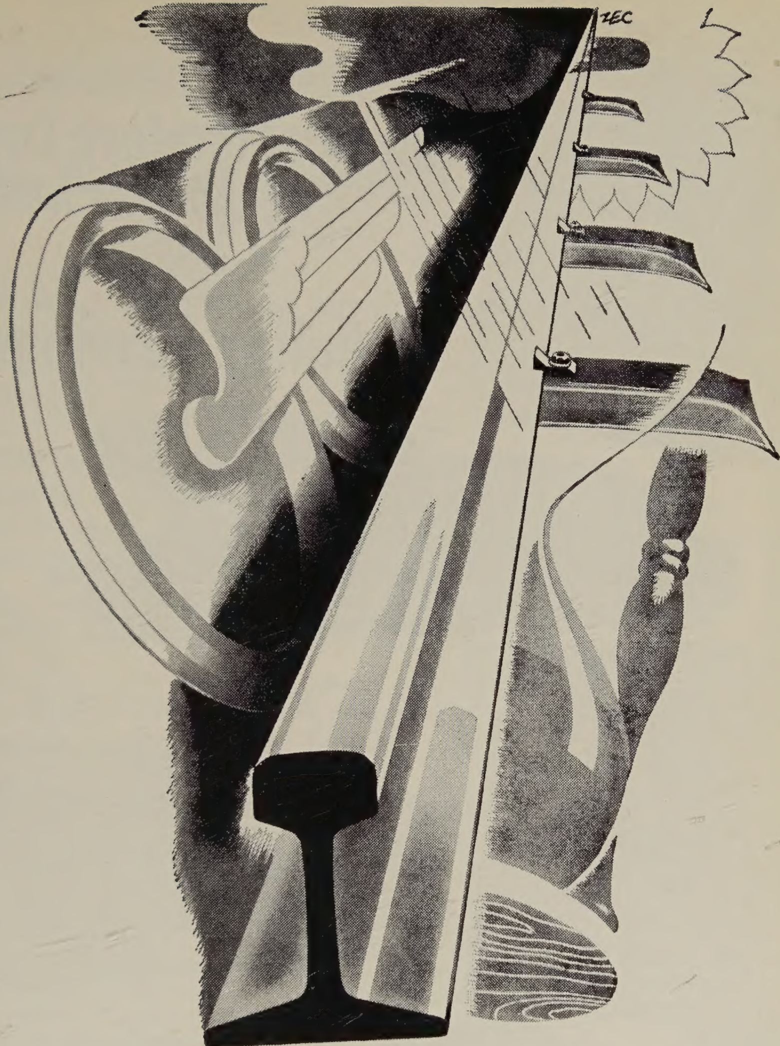

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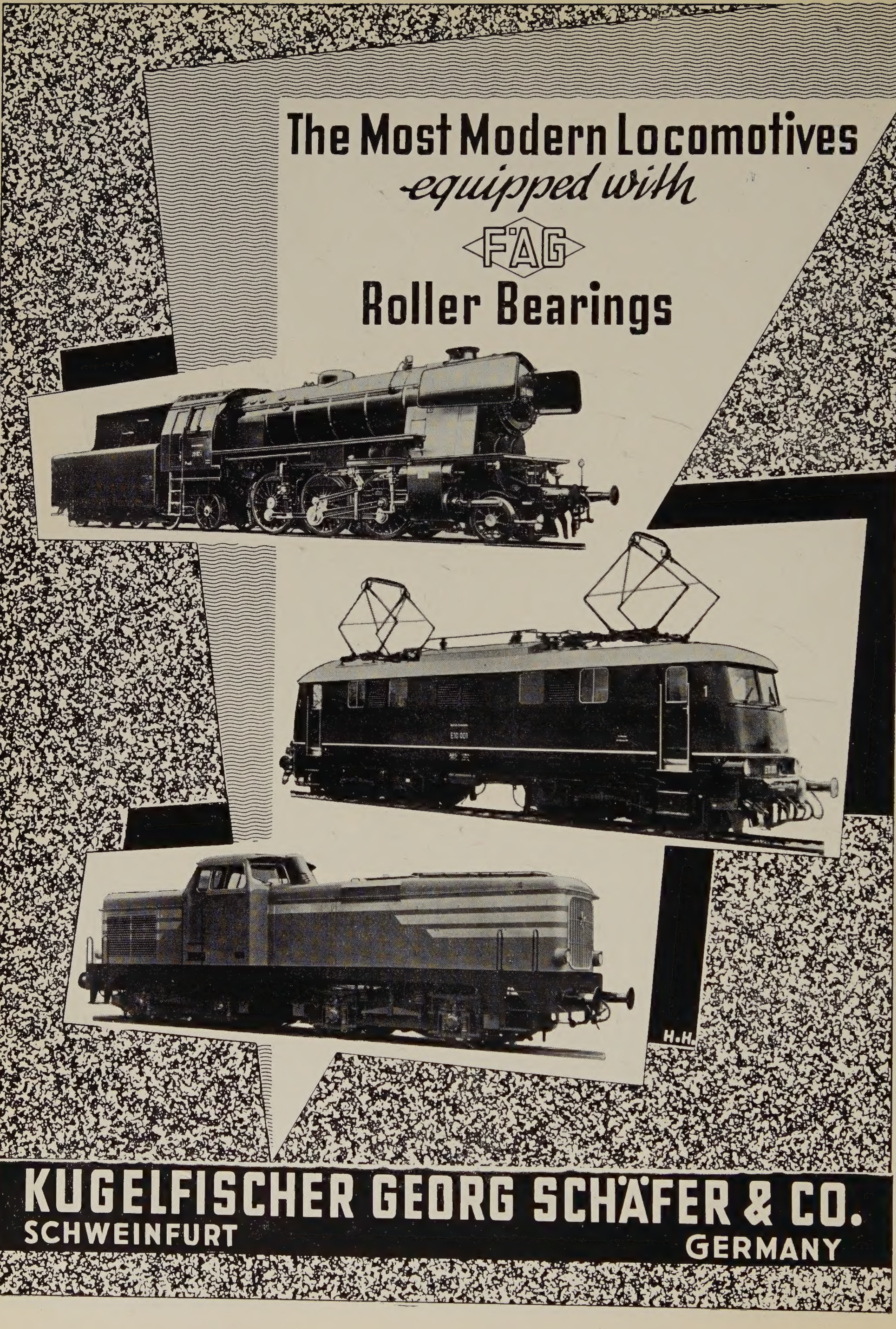
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OF THE

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

(ENGLISH EDITION)

PUBLISHING and EDITORIAL OFFICES : 19, RUE DU BEAU-SITE, BRUSSELS

Yearly subscription for 1956 :	**Belgium . . . .**	**700 Belgian Francs**
	Universal Postal Union . .	**800 Belgian Francs**

Price of this single copy : 80 Belgian Francs (not including postage).

Subscriptions and orders for single copies (January 1931 and later editions) to be addressed to the General Secretary, International Railway Congress Association, 19, rue du Beau-Site, Brussels (Belgium).

Orders for copies previous to January 1931 should be addressed to Messrs. Weissenbruch & Co. Ltd., Printers, 49, rue du Poinçon, Brussels.

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Vol. XXXIII. — No. 4. April 1956.

BULLETIN
OF THE
INTERNATIONAL RAILWAY CONGRESS
ASSOCIATION
(ENGLISH EDITION)

[656 .21 & 656 .25]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

ENLARGED MEETING OF THE PERMANENT COMMISSION
(THE HAGUE-SCHEVENINGEN, 1956.)

QUESTION 1.

Research on the economic usefulness and the technical opportunity to install a third track, serving for common use (banalisation), in addition to sections of double track lines with heavy traffic, instead of installing two double track lines on such sections.

Consequences of the installation of a third track for use in either direction on the conditions necessary to insure the safety of train movements.

REPORT

(Austria, Belgium and Colony, Bulgaria, Cambodia, Czechoslovakia, Denmark, Ethiopia, Finland, France and French Union, Germany (Federal Republic), Greece, Hungary, Indonesia, Italy, Luxemburg, Poland, Portugal and overseas territories, Rumania, Spain, Switzerland, Syria, Turkey, Viet-Nam and Yugoslavia),

by E. Tenti,
Inspecteur en Chef du Service du Mouvement des Chemins de fer de l'État italien,
and A. Riggio,
Inspecteur en Chef du Service de la Voie des Chemins de fer de l'État italien.

I. Introduction.

General considerations.

This report is based upon the information supplied and observations made regarding this question, by the following Railways :

— Austrian Federal Railways;
— Swiss Federal Railways;
— Italian State Railways;
— North of Milan Railways;
— Deutsche Bundesbahn;
— Red Nacional de los Ferrocarriles Españoles;
— Belgian National Railways (S. N. C. B.);
— French National Railways (S. N. C. F.).

The other Administrations to whom the questionnaire was sent stated that they were not able to give any useful answers to the questions asked.

Amongst the above Railway Administrations, only three (Deutsche Bundesbahn, Belgian National Railways and French National Railways) were able to supply precise data concerning three short sections of line on which a third track in common user was already in operation; other information, received from the D. B. and S. N. C. B., dealt with two sections of line on which a third track in common user is being introduced. The S. N. C. F.

and the R. E. N. F. E. supplied data concerning proposals to install a third track in common user, whilst the Italian State Railways gave us the factors used for comparing the two solutions: « three tracks » or « four tracks », on one line of their system. Finally, the Austrian Federal Railways, the Swiss Federal Railways and the North of Milan Railways supplied us with considerations of a general order.

* * *

In principle, when it becomes necessary to make substantial modifications to the equipment of a railway line which has reached the limit of its capacity, the first consideration is to decide whether the solution chosen will enable the line to meet not only existing operating requirements or those now developing, but also those likely to occur in the future. In making such an evaluation, in view of the uncertainty of the factors to be taken into consideration for the future, the operators will more often prefer the most complete equipments, i. e. the most costly.

On the other hand, the reduction of the expenditures for equipping and maintaining the lines is one of the most essential objects in view, so that it is necessary to reconcile to the greatest possible extent the exigencies of the operating and of economy. For this reason, the equipment of an over-burdened railway line is one of the most delicate problems facing Railway Administrations.

Our study covers the economical usefulness and technical justification for installing a third track equipped for common user, in addition to the double track sections with very heavy traffic, instead of doubling these sections. In this study by the « third track » must be understood an additional line over the whole of a double track section from one station to another or between a station and a branch line which is not part of the station and which is used for the train services. On lines with centralised traffic control (C. T. C.), there may also be sections of a third track included in the stations sufficiently long to be used as sidings, but, in this type of C. T. C. installation, the boundary between the « stations » and the « line sections » from the operating point of view may be very indefinite.

The factors available for our study are relative to a limited number of sections of line with three tracks, as the solution of a « third track with common user » has not been made use of to date in many cases in the countries covered by our enquiry. We may ask ourselves to start with why this disaffectation and the preference given to the solution of « doubling the lines »; we will only be able to reply to this question after the detailed analysis of the problem.

In this Report, we will consider first of all the data supplied by the Administrations consulted, and will endeavour to arrive at suitable summaries on the whole problem, taking into account the opinions expressed in the replies.

II. Existing three and four track lines. — Characteristics of sections of line on which a third line with common user has been introduced.

According to the information received, at the present time on the systems of the Administrations who replied, there are about 806 km (503 miles) of four track lines (440 km [273 miles] of which are electrified) and 145 km (90 miles) of three track line (of which 75 km [46 miles] are electrified). However, the great majority of these three track sections, because of the characteristics of their user and equipment, must be considered rather as a whole consisting of two distinct lines side by side, one with two and the other with one track, rather than a single three track system to cope with common traffic and utilised according to the momentary needs of the operating which is more particularly the subject of our investigation.

With this type of line with a third track in common user, the following sections are

in service at the present time in the countries covered by our report : Ludwigsburg-Bietigheim section (Western Germany) 9.5 km (6 miles), Genval-La Hulpe (Belgium) 2 km (1.24 mile), and the Houilles-Sartrouville (France) 3 km (1.86 mile). A third track in common user is now being installed on the sections : Wiesbaden Hbf-Wiesbaden Ost line (Western Germany) 2.5 km (1.5 mile) and Brussels - Hal (Belgium) 13.6 km (8.44 miles) with 3.7 km (2.30 miles) having four tracks.

To get a clear picture of the situation and to facilitate the necessary comparisons, the characteristics of equipment and of operation of these three track sections are summarized in the table hereafter (pp. 326/16 to 330/20).

III. Third track installations under study.

Apart from the information relating to lines already in service or being installed, we received data concerning proposed new installations of a third track in common user to be made on the following sections of lines belonging to the French and Spanish Railways.

1. — *Orry-La Ville-Creil line (France).*

— Length of third track in common user : 15 km (9 miles).

— In the centre (continuation of a four track section).

— Only one intermediate station.

— Average length of sections between two stations : 7.5 km (4.5 miles).

— Max. speed on tracks for one direction only : 140 km (87 m.p.h.) (railcars) 130 km (80 m.p.h.) (trains).

— Max. speed on common track : not yet decided, probably 80 km (50 m.p.h.).

— Max. down gradient : 5 mm/m in the Orry-Creil direction.

— At the present time, the number of trains in both directions — all categories together — varies between 150 (normal days) and 200 (peak days).

2. — *Aulny-Mitry line (France).*

— Length of third track in common user : 13 km (8 miles) without intermediate stations.

— On one side (continuation of « suburban » lines).

— Max. speed on tracks for one direction only : 110 km (68 miles)/h.

— Max. speed on the common track : not yet fixed, probably 80 km (50 miles)/h.

— Max. down gradient : 5 mm/m in the Mitry-Aulny direction.

— Number of services in both directions — all categories together — is at the present time between 130 (normal days) and 180 (peak days).

3. — *Las Matas-Villalba line (Spain).*

— Length of third track in common user : 14 km (8.7 miles).

— At one side : to avoid substantial modifications to the stations and to facilitate shunting goods trains.

— One intermediate station.

— Average length of sections between two stations : 7 km (4.3 miles).

— Max. speed on the section : 120 km (74.5 miles)/h.

— Max. gradient : 16.4 mm/m in one direction of running.

— For both directions, the total number of trains is at present between 130 (normal periods) and 198 (peak periods) of which 60 are freight trains and locomotives in normal periods and 78 freight trains and locomotives in peak periods; the traffic is expected to increase.

— The common track is intended for use by slow suburban trains, and freight trains and light locomotives.

— The installation of light signals, automatic block and centralised control of points and signals is proposed.

IV. Analysis of the considerations from the double aspect of operating and installation, which led the Administrations to choose the adopted solution : third track with common user « or » four tracks.

We will examine first of all the reasons which led the Administrations to

CHARACTERISTICS OF LINES WITH A THIRD TRACK IN COMMO

Railway Administration	Three track section under study		Length km	Position of the track with common user in relation to the other two tracks	Number of intermediate stations		Average length of sections between two adjacent sidings km
					With sidings	Without sidings	
Deutsche Bundesbahn	In service	Ludwigsburg-Bietigheim	9.5	In the middle	1	1	3.15
	Third track being made	Wiesbaden Hbf-Wiesbaden Ost	2.5	In the middle	—	—	—
Belgian National Railways	In service	Genval-La Hulpe	2	At one side (on the same side as the local stations in order to facilitate shunting the trains)	—	—	—
	Third track being made	Brussels-Hal	9.9	At one side (in order to avoid the platforms of intermediate stations)	1	1	3.3
French National Railways	In service	Houilles-Sartrouville	3	In the middle	—	—	—

JSER IN SERVICE OR BEING MADE ON THE DIFFERENT RAILWAYS

Max. speed km/h	Maximum speed on the connections between the line in common user and the lines for one direction of traffic only km/h	Maximum gradients on the line both directions of running		Signalling		
		Up	Down	Type	Number of intermediate speeds between maximum speed and stop	Average length of signalling sections km
90 to 100	40 to 65	10 ‰ (11.66 ‰ over 166 m)	down-gradient (14.28 ‰ over 175 m)	Light and Semaphore	3 (30 - 40 - 60 km/h)	0.8 — 1.00
85	85	6.25 ‰	—	Light	1 (30 km/h)	0.950
20 (on tracks in one irection only) 40 (on track with common user)	40	12.4 ‰	down-gradient 7.4 ‰	Light	Various values (figures showing tens of Km/h)	1.00
140 (on tracks in one irection only) 90 (on track vith common user)	40	4.7 ‰	down-gradient 3.8 ‰	Light	Various values (fig. showing tens of Km/h)	1.250
20 (on tracks in one irection only) 80 (on track vith common user)	80	2 ‰	—	Light	1 (80 Km/h)	1.2

	Number of services on the line each day : normal days / peak days							Special features of the traffic on th[e] three track secti[ons]
	Up			Down			Total on the line	
	Passenger	Freight and loco-motives	Total	Passenger	Freight and loco-motives	Total		
Deutsche Bundesbahn	112 / 120	72 / 83	184 / 203	114 / 122	74 / 82	188 / 204	372 / 407	The traffic is ve[ry] heavy in both dire[c]tions at the sam[e] times of day: th[e] gradient on th[e] Bietigheim-Ludwi[g]burg run increase[s] the journey time in this direction.
	134 / 134	—	134 / 134	134 / 134	—	134 / 134	268 / 268	It is necessary to co[pe] with very heav[y] peak traffics i[n] the same direction especially at certai[n] hours from Wie[s]baden Hbf (abou[t] one train every tw[o] or three minutes
Belgian National Railways	70 / 70	20 / 20	90 / 90	70 / 70	20 / 20	90 / 90	180 / 180	Traffic peaks at an[y] given period are i[n] one direction only provision has bee[n] made for dealin[g] with peak traffi[c] of 20 trains i[n] the same directio[n] during a period o[f] 2 hours, such train[s] running at clos[e] intervals.
	According to estimates after electrification							
	98 / 98	17 / 17	115 / 115	98 / 98	17 / 17	115 / 115	230 / 230	It is necessary t[o] cope with heav[y] peak traffic in th[e] same direction an[d] to let the faste[r] trains run past th[e] slower trains durin[g] the run.
	According to estimates after making the third track							
French National Railways	—	—	100 / 125	—	—	100 / 125	200 / 250	Very heavy peal[k] traffic in one direc[-]tion in the mornin[g] towards Paris, i[n] the evening awa[y] from Paris, 50 train[s] in two hours, abou[t] 10 lay by sidings i[n] use daily in eac[h] direction of run[-]ning.

Number of trains daily using the third track in common use (including trains which only use it for part of their run) : normal days / peak days							Maximum number of services per hour on the line			
Up			Down			Total on the line	Up	Down	Total on the line	On the track in common use
assenger	Freight and loco-motives	Total	Passenger	Freight and loco-motives	Total					
63/72	1/7	64/79	25/29	5/9	30/38	94/117	10	10	20	6
46/46	—	46/46	48/48	—	48/48	94/94	—	—	14	5
(According to estimates after installing the third track.)										
(According to momentary needs, especially for goods trains.)							10	4	14	As neces-sary
15/15	2/2	17/17	15/15	2/2	17/17	34/34	13	6	19	7
(According to estimates after installing the third track.)										
—	—	25/25	—	—	25/25	50/50	—	—	15	3

Railway Administration	Basic system for assuring safe running	Regulation of the running of trains and use of the three tracks	Centralised control of points and signals: Technical capacity of the central control post	Centralised control of points and signals: Working part of the central control post	Adoption of any special measures or means to promote better control of the traffic
Deutsche Bundesbahn	Automatic block (manual block in station sections)	Preliminary programme and regulation by dispatching (in carrying out the programme a daily average of 25 trains in each direction of running is moved from one track to another in the section).	—	—	—
	Automatic block	Preliminary programme and regulation by centralised control.	Control by route. Number of orders : 48 Number of announcements : 150 Orders and announcements can be stored.	Maximum number of operations per hour : 24.	Automatic train running recording equipment is on trial. Use is also going to be made of automatic indicators showing the train numbers. There is no radio-communication.
Belgian National Railways	Automatic block	Preliminary programme and regulation by dispatching	—	—	—
	Manual block	Preliminary programme and regulation by dispatching.	—	—	—
French National Railways	Automatic block	Preliminary programme and regulation by centralised control.	Individual control and control of 22 points and 14 signals.	Setting up a route according to its complexity may require 2 to 7 interventions by the operator, who also has to assure at the same time the regulation by dispatching of a section of line without C.T.C. covering in all 60 km.	—

LUDWIGSBURG-BIETIGHEIM (W.).

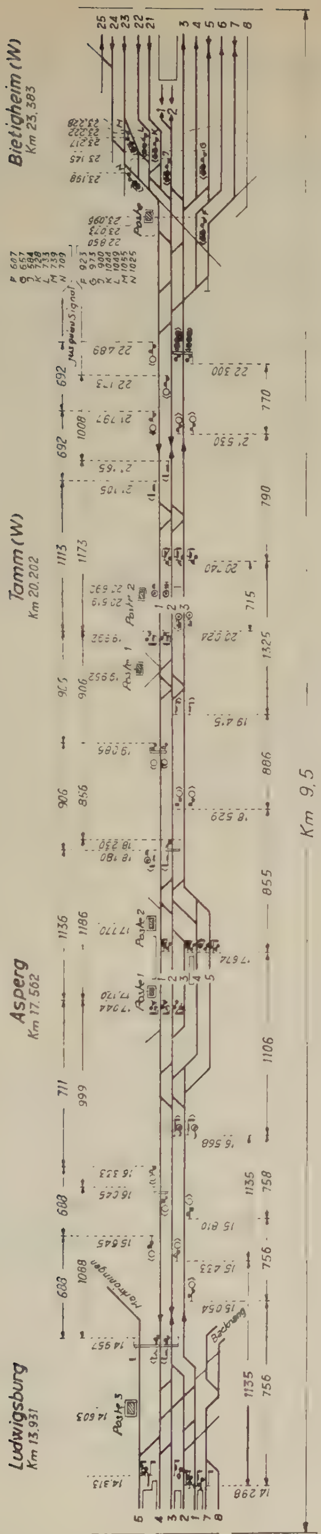


Fig. 1.

prefer sometimes « three tracks » or sometimes « four tracks » in the case of both existing or projected installations.

1. — *Three track Ludwigsburg-Bietigheim* — km 9.5 — *section near Stuttgart* (Germany) (fig. 1).

Owing to the increased traffic after the war, the existing three tracks (2 up, 1 down) were no longer sufficient. The estimates for a fourth track were very high, so to begin with it was decided to obtain the maximum output from the three tracks by reducing the length of the block sections, and installing automatic block; introducing common user on the central track, and by electrifying the line, to shorten the up journey times.

The improvement brought by common user of the third track is however limited owing to the fact that the traffic is very heavy in both directions at the same periods; under these conditions the differences between the speeds of the various classes of passenger and goods trains complicate the work of the regulator, both for the choice of the route to follow and the time at which the change over of track takes place. In addition, the choice of track to be used by a train is sometimes limited by the fact that certain changes, involving a change of platform, would upset the passengers and if ordered at the last moment lead to loss of time.

In spite of these drawbacks, common user gave good results and there is no doubt that it has contributed to the increased capacity of the line. Further improvement will be realized as soon as the station signalling has been modernised, to make full use of the advantages of the automatic block, which is now interrupted in the stations; finally, centralised traffic control (C. T. C.) could also improve the regulation of the trains. Nevertheless, in view of the amount of the existing traffic and of its characteristics, it is considered that the capacity of the three

track line will be reached should the number of trains increase to any great extent.

The following table shows the actual capacity of this section before and after equipping :

Three track line Ludwigsburg-Bietigheim

Equipping : — common user / — electrification / — automatic block	Number of trains per 24 hour period		
	Lu-Bm direction	Bm-Lu direction	Total
Actual capacity : *before* equipping	127	132	259
after equipping	209	211	420

The increase in the actual capacity of the line is therefore 62 % ($100 \frac{420 - 259}{259}$); however, this increase is the result of adopting all three measures (electrification, automatic block, common user of the centre track). Even if other factors now missing were known, it would be difficult to estimate the part in the increased output attributable to each of these improvements.

Regarding the comparative examination of the solution adopted and having four tracks, account must be taken of the fact that there was already a third track on the Ludwigsburg-Bietigheim section; it was only necessary to realize the common user, to modify the ways into and out of the stations and the signalling installations. Common user was therefore in this case, a solution of moderate cost compared to the cost of the « four tracks » solution; and it was given preference on this account.

However for the sake of making a comparison, between « three track » and « four track », we give below the estimated cost involved if equipment of the section considered would have had to be realized for both solutions, taking the double track as basis.

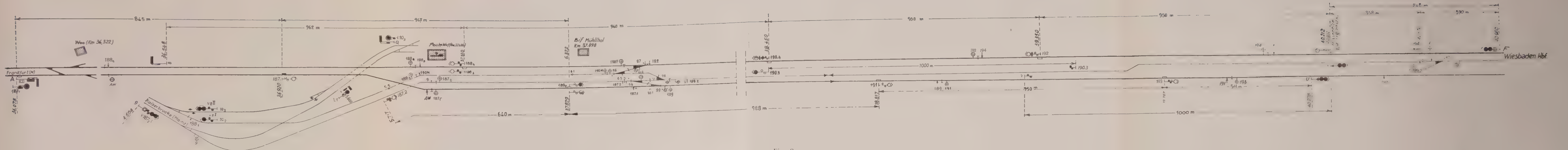
a) Estimated cost of laying a third track for common user on the Ludwigsburg-Bietigheim section :

— Alteration to stations, including signalling .	4 490 000 D.M.
— Laying a third track .	2 750 000 D.M.
— Installing automatic block	800 000 D.M.
— Common user . . .	1 400 000 D.M.
Total cost . . .	9 440 000 D.M.

b) Estimated cost of making four tracks the Ludwigsburg-Bietigheim section :

— Alteration to stations, including signalling .	5 450 000 D.M.
— Laying two tracks . .	5 800 000 D.M.
— Installing automatic block	950 000 D.M.
Total cost . . .	12 200 000 D.M.

The ratio between the cost of the two solutions is therefore $\frac{9.44}{12.20} = 0.77$ which would be still higher if centralised traffic control were introduced.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988 m
1000 m

Fig. 2.

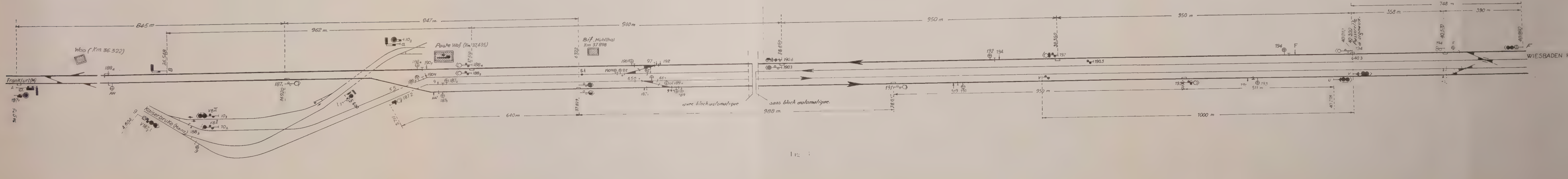
Frankfurt (M)
WIESBADEN Hbf.
Woo (Km 36.322)
Poste Wof (Km 37.435)
Bif. Mühlthal Km 37.898
Kaiserbrücke (Mainz)
avec block automatique
sans block automatique
845 m
947 m
962 m
940 m
950 m
640 m
988 m
1000 m
358 m
390 m
748 m

Fig. 3

2. — *Three track Wiesbaden Hbf-Wiesbaden Ost* — km 2.5 — *section* (Western Germany) (fig. 2).

Three track with common user and C. T. C. was preferred to four track (fig. 3) because as most of the traffic normally was carried on the two tracks for one direction only with short block sections, the trains using the third track only occurred as groups of trains running at close intervals in the same direction. The system was also more suitable for the entry to Wiesbaden station, as it was easier to connect the three tracks to the station platform than it would have been to connect four.

The following figures show the actual hourly capacity of the section :

Two tracks	24 trains
Three tracks	32 trains
Increased capacity	8 trains

The increase in the real output is therefore : 33 % $(100 \times \frac{8}{24})$.

The cost of equipping a third track with common user in the case of the Wiesbaden Hbf-Wiesbaden Ost section, including the alterations to the stations, the automatic block and signalling installations, was 1 210 000 D.M. (cost of signalling only : 427 000 D.M.). To have four tracks with the same automatic block equipment and points between tracks in the same direction at Mühlthal junction would have cost about 2 million D.M. (the cost of the signalling would have been about the same).

The ratio between the cost of the two solutions is therefore : $\frac{1.21}{2} = 0.6$.

3. — *Three track Genval-La Hulpe line* — km 2 — (Belgium).

On this three track section the traffic peaks only occur in one direction at any given moment, and such peaks last about two hours; the local station installations, for goods, are served from the third track which is to one side compared to the two tracks for one direction only; nearly all the goods trains running on the third track are shunted in the stations.

4. — *Three track Brussels-Hal section* — km 9.9 — (Belgium).

On this section of line, on which the third track is now being installed, the traffic peaks are towards Brussels in the morning and from Brussels in the evening; these peaks last 2 and 3 hours respectively; the third track on one side, will be used as a lay by line by goods trains connecting the intermediate stations and slow passenger trains, several of which are passed during their run by faster trains.

5. — *Three track Houilles-Sartrouville section* — km 3 — (France) (fig. 4).

This installation with a centre third track in common use was put into service in 1933, was intented to cope with a relatively heavy suburban traffic at the same time as the « main line services » between Paris and Le Havre; most of the suburban trains to the two stations of Houilles and Sartrouville use the common track.

This solution was adopted owing to the considerable difficulties of making a fourth track (long embankments necessary). The C. T. C. installation has saved eight pointsmen.

6. — *Proposed three track installation on the Las Matas-Villalba line* (Spain).

On this 14 km (8.69 miles) long section, three tracks were preferred instead of four, on account of site conditions; it was considered advisable to have the third track at one side so as not to have to make any important alterations to the existing stations and to facilitate the

direct passage of goods trains from the third track to the marshalling yard and to the goods installations of Villalba station.

Traffic peaks due to the simultaneous running at certain periods of the day of suburban and long distance trains occur in one direction in the morning and in the opposite direction in the evening. The third track in common use will be used above all by stopping suburban trains and goods trains and also for the numerous runs of light locomotives.

In 1952, the advisability of installing a third track or two new tracks on this section was examined, in order to:

— separate the short distance traffic from the long distance traffic, owing to the different running speeds and the stops made by the former during the run, and to concentrate this short traffic distance on the centre track;

— to bring back the long distance trains to the main Düsseldorf (Central Station)-Duisburg (Central Station) line, which had had to be deviated as the capacity of the line was not sufficient;

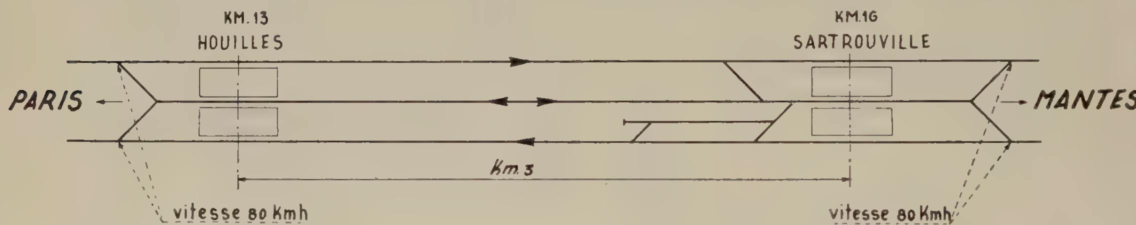

Fig. 4.

N. B. — Vitesse = speed.

7. — *Proposal to make the Düsseldorf Hbf-Duisburg Hbf section a four track section* (Western Germany).

This section is 16.3 km (10.12 miles) long with an intermediate station and several branch lines; gradient 0.5-0.6 $^{0}/_{00}$; speed allowed: 100-120 km (62-74 miles)/h; 240 trains daily, peaks of 256 trains; relay blocks and light signals.

The Düsseldorf (Central Station)-Duisburg (Central Station) section is part of the main line from the south of Germany along the Rhine, through Bonn, Cologne, Düsseldorf, administrative and railway centre, and Duisburg, a railway junction and distribution centre for the industrial region of the Ruhr (Emmerich). In view of the very special position of this line, the traffic flow is just as important towards the north as towards the south. So is the workmen's traffic over short distances and the long distance passenger traffic.

— to improve traffic conditions over the short distances in view of the importance of this traffic.

The results of this investigation showed that the most rational solution to obtain an increase in the capacity of the line would be to have four tracks.

One of the reasons, which dictated this decision, was the existence of a wide enough bed and bridges for four tracks, as the line used to be a four track one formerly. On the other hand, to have had three tracks would have involved substantial modifications to the important installations at the entry to Duisburg station, whereas four tracks made it possible to have two pairs of tracks on different platforms in the junctions of Düsseldorf and Duisburg.

As far as the traffic characteristics are concerned, the fact that there were a great many trains in both directions during peak hours led to problems, which could not be completely resolved by lay-

ing a third track, even if this was in common use.

The situation was also studied with the electrification of the three tracks and it was found that electrification would only lead to a slight increase in capacity, which would not make up for the advantages of having four tracks.

The difference in the cost of the two solutions was relatively small for the above mentioned reasons: existing bed wide enough for four tracks, and simplification of the connection with the entry to Duisburg station in the case of four tracks.

The ratio between the total cost of three and four tracks could be estimated as follows.

a) Alterating the double track section into a three track section with common user, home and distant signals, automatic block, central train regulation (but not central train control) :

— for the signalling . .	3.6 M D.M.
— for the track . . .	4.9 M D.M.
	8.5 M D.M.

b) Making the double track section four track without common user and without central train regulation (as under *a*) :

— for the signalling . .	3.4 M D.M.
— for the track	6.6 M D.M.
	10.0 M D.M.

Ratio between costs $\frac{8.5}{10} = 0.85$, which would be still higher if centralised traffic control were provided.

8. — *Brussels-Ghent four track section* (Belgium).

This 52 km (32 miles) long line is one of the main routes for bringing workmen and employees to Brussels and a section of the most direct link between the interior of the country and the Belgian coast; it is also run over by international traffic London-Cologne, via Dover-Ostend.

During the summer season, the traffic peaks « workers » and « seaside » in opposite directions occur simultaneously at certain hours of the day.

Under these conditions, the line was made four tracks as three tracks were considered an inadequate solution.

9. — *Brussels-Antwerp four track section* (Belgium).

The passenger traffic of this 44 km (27 miles) long section, which links up the two largest cities in the country (population served: about 2 000 000 people), occupied to capacity the two lines reserved for it. On the other hand, there is an important goods traffic from the port of Antwerp to the interior of the country.

It was considered quite out of the question to limit the scheme to three tracks.

10. — *Fexhe-Liège four track section* (Belgium).

This section of line which is now four track, is 14 km (8.7 miles) long and the two oldest tracks include two down gradients of 30 mm/m over more than 3 km (1.86 miles); the traffic is fairly heavy, and before the section was made four track, the down track was practically used to capacity owing to the fact that the locomotives used to push the trains up the gradient ran back light (doubling the number of services in this direction). The slope of the line was also a major drawback for the goods traffic, not only in the up direction but also on the down grade, owing to the exceptional braking demands. Finally, at the foot of the gradient Liège (Guillemins) station, skimped and inextensible, constituted a bottleneck where the passage

of goods trains was a permanent cause of trouble.

Under these conditions, rather than double the down line, which would only have solved one of the difficulties, but would have left the drawback of the major down gradient, it was preferred to make a new double track line on a different route, avoiding Liège (Guillemins) station and having much less of a gradient (12 mm/m). This new route is reserved for goods trains only.

11. — *Namur-Ronet four track section* (Belgium).

This section 4 km (2.48 miles) long links up Namur station (railway junction of several lines with heavy traffic, in particular goods) to the marshalling yard of Ronet, on the side of the Namur-Charleroi line. The latter is run over by a important passenger traffic: workmen's trains and international trains Paris-Cologne. In addition, the locomotive shed serving Namur junction is installed at Ronet.

This accumulation on the short section Namur-Ronet of movements of various kinds, which can be dealt with separately, should lead normally to the adoption of the four track solution and the rejection of the third track in common use of insufficient capacity. The two additional tracks are normally used by the goods trains and the locomotives.

12. — *Proposed three or four track alteration for the Treviglio-Pioltello line* (Italy).

This 20.7 km (12.87 miles) long double track section, close to Milan, is used for the long distance Venice-Milan trains, the trains from the Bergamo and Cremona branch lines, and the local worker's trains, as well as the goods trains for Milano Smistamento marshalling yard. The total number of trains daily is 160, but at certain hours there are very heavy peaks. For this reason, the characteristics of the traffic excluded common user on the two tracks, it was decided to study comparatively the two solutions: three or four track section.

The investigation carried out led to the following conclusions:

— as far as operating requirements were concerned, three tracks though involving certain restrictions compared with four tracks, would be sufficient;

— in view of the advisability of having the third line in common use in the centre (in order to improve partial sections in common use), it would be necessary to modify very considerably the existing arrangement of the tracks and equipment of the four stations on the line, which would increase the cost of the three track solution; in addition, carrying out the work on a line with such heavy traffic would be a very serious strain to the working;

— four tracks, in view of the situation of the site, would not be unduly costly, the more so as it could be planned and carried out without modification of the existing lines and without disruption in the service (fig. 5);

— the ratio between the estimated cost for the two solutions « three track with common user and C. T. C. » or « four track » is:

$$\frac{3\,140 \text{ million lires}}{4\,330 \text{ million lires}} = 0.72.$$

At the present time, in view of the above factors, subject to a more detailed examination of the three track solution, the Italian State Railways are inclined to regard four tracks as the solution, which would moreover give greater operating possibilities than three tracks.

13. — *Austrian lines.*

In Austria, there are some three track sections, but these in practice are two sets of lines side by side, one with two tracks and one single track, clearly separate from the point of view of utilisa-

tion. It is the same in the case of the only four track section, Hütteldorf Hacking Unter Purkersdorf, 6 km (3.72 miles) long, where each group of two tracks is allocated to a clearly defined traffic, which moreover is not very heavy, mixed use in each direction not being normally provided for. The position of these lines offers no precise basic elements for solving the problem under consideration.

single direction tracks and the common track must be able to cope with high running speeds, if possible equal to the maximum speed allowed on the lines in question.

14. — *Lines of the Swiss Railways.*

The Swiss Federal Railways (C. F. F.) have no three track sections as yet; on the other hand, they only have one

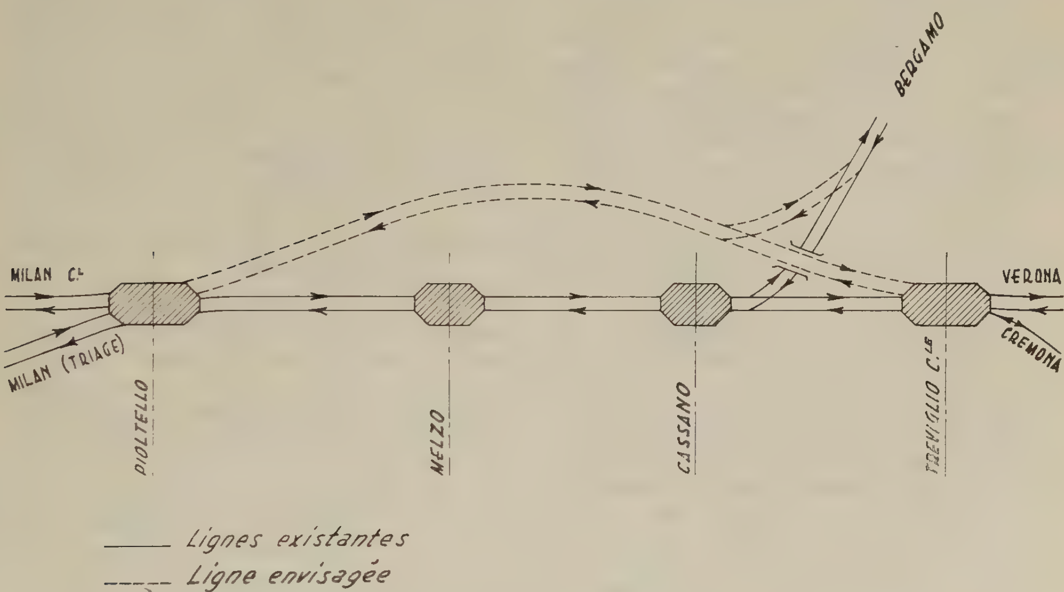

Fig. 5.

N. B. — ——— Lignes existantes = existing lines. — ------ Ligne envisagée = proposed line.

In principle, the Austrian Federal Railways consider that three tracks can be used instead of four over short sections, especially in those cases where the nature of the site makes it impracticable or very costly to have four tracks, always provided of course the characteristics and amount of traffic enable this to be done. In such cases, the solution with the common track in the centre of the two tracks for one direction of traffic only is considered in principle to be the best for the passage of trains from one track to the other; the connections between the

short four track section, Berne-Wylerfeld, 2.3 km (1.42 mile) long. The question will doubtless arise some day of providing a third track on certain heavily loaded two track sections; so far however no proposal nor any detailed study has been made regarding the construction and working of such a third track.

The sections, which would need dealing with, would be mainly in heavily built up areas within the perimeter of large cities, so that the problem of finding sufficient room for a third track and even more so, for two new tracks is

very serious. As building land is becoming more and more rare in Switzerland, prices are very high and have an unfavourable effect upon the cost of construction. Therefore the C. F. F. would not consider building a third or fourth track until every other method of increasing the capacity of double track lines had been exhausted. First of all, they are trying to install the automatic block system, equipping intermediate stations with access to platforms without crossing the track, increasing the number of passing points and levelling out as much as possible the average speeds of various categories of trains (through trains, stopping trains, goods trains), by using up to date powerful motor stock; programme greatly facilitated by the almost complete electrification of the system.

On the Swiss Railways, the most heavily loaded group of lines (more than 220 trains a day), is constituted by relatively short sections, especially in the case of the common sections (the longest of them, Brugg-Zürich is about 31 km [19 miles] long). Traffic peaks in one direction only occur especially on certain runs with shuttle services for workmen, for a brief period during the morning, at midday and in the evening. If, at such periods, there is also some traffic in the opposite direction, though very little, common user of the two existing tracks would not achieve the desired object and it may be necessary to consider making a third track in common use.

15. — *Additional considerations.*

After analysing the different solutions chosen in practice by the various Administrations, we think it of interest to add the following considerations.

a) In connection with the data given in the previous table, relating to lines where there is a third track in common use, it seems advisable to stress the fact that :

— the percentage of trains using daily the third track in common use varies from 15 ($100 \frac{34}{230}$, Brussels-Hal line, 13.6 km) to a maximum of 37 ($100 \frac{95}{258}$) Wiesbaden Hbf-Wiesbaden Ost (2.5 km); these percentages are shown in figure 6;

— difference between the actual user of the third track of this theoretical programme, represents 13 % ($100 \frac{50}{372}$) of the daily movements on the section Ludwigsburg-Bietigheim line (9.5 km);

— the resulting usage of lay by sidings represents 10 % ($100 \frac{20}{200}$) on the Houilles-Sartrouville line (3 km);

b) As regards the cost of the necessary modifications we have recorded, in some of the practical examples examined, interesting data which have enabled us to establish the ratio between the total costs for three or four tracks.

In this connection, the Belgian National Railways, without giving figures, state that the average ratio of the total cost for three or four tracks, not including the cost of the bed and the cost of the site, can only be estimated approximately chiefly on account of the fact that the modifications to the stations will differ very considerably from one case to another.

In our opinion, the following figures may be taken into account for the ratios of the costs of installation between the two solutions : three track (= 1) and four tracks :

— for the track . . . . 1 : 1.75
— for the contact lines for the electrification . . . . 1 : 1.85
— for the automatic block signalling 1 : 1.05

On the basis of these factors, the above

average ratio of cost between « three track » or « four track » would be about 0.6, it may however vary (being either greater or smaller) when all the cost in connection with the site, the permanent way with any bridges required, the modifications to the stations, the installation of C. T. C., etc., are taken into account, i.e. the total costs.

prices of site), whereas with only three tracks such steps are not required.

It appears of interest to underline the fact that with « three track », even when the common track is to be in the centre, it is possible to make one of the two old tracks suitable for common use without modifying the usual space between the tracks, the new track for one direc-

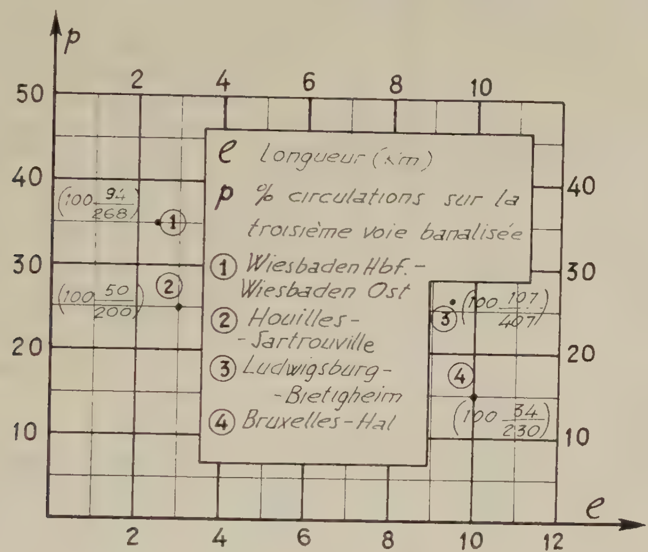

Fig. 6.

N. B. — L = length. — P = per cent movements on third track in common use.

For the various concrete cases examined, the ratio of the costs for « three track » or « four track » varies from 0.6 (section of the Wiesbaden Hbf-Wiesbaden Ost line, with a limited amount of work at the end stations) to 0.85 (section of the Düsseldorf Hbf-Duisburg Hbf line, where there was already an existing bed for four tracks). This ratio may be less than 0.6 and even 0.5 it is the case when, for example, it is question of double lines in special positions (close to large cities, difficult site conditions, etc.) such as « four tracks » would involve high expenses (making embankments and much structural work, very costly purchase

tion of running only being built alongside. The section of the Ludwigsburg-Bietigheim line, for example, has spaces of 4 m and 5.4 m (13′ 1 1/2″ and 17′ 8 3/4″) respectively between the axes of the three tracks.

c) As regards maintenance costs, the following table is of the greatest interest. Relating to the French system, it gives for a line of 6 km (3.72 miles) a comparison of the maintenance costs for a double track line with automatic block, a third track in common use with C. T. C. and a four track section with automatic block.

	Double track with automatic block (6 km section)				Three tracks one with common user and C.T.C. (6 km section)				Four tracks with automatic block (6 km section)			
	Permanent way	Signalling	Catenary 1 500V	Total	Permanent way	Signalling	Catenary 1 500V	Total	Permanent way	Signalling	Catenary 1 500V	Total
Maintenance staff : — hours . . . . (per annum)	22 600	960	3 500	23 910	31 500	1 680	5 000	38 180	38 700	1 800	6 500	47 000
— wages . . . . (per annum)	7 800 000	380 000	1 400 000	9 580 000	10 900 000	670 000	2 000 000	13 570 000	13 400 000	720 000	2 600 000	16 720 000
Maintenance of installations . (materials)	8 500 000	250 000	430 000	9 180 000	10 800 000	500 000	650 000	11 950 000	12 800 000	500 000	860 000	14 160 000

An examination of the adjoining table, shows the following ratios between the number of working hours of the maintenance staff and the expenditures (wages and materials) for the three solutions :

— number of working hours 1 : 1.59 : 1.96
— expenditures for wages . . 1 : 1.42 : 1.74
— expenditures for materials. 1 : 1.3 : 1.54

The total annual cost of wages and materials would be in the ratios of 1 : 1.37 : 1.63 which are not in fact the true economic ratios.

To obtain the ratios per unit of transport (tonne-kilometre, axle-kilometre), the above figures must be divided by the volumes of traffic corresponding to the three cases considered, related to the double track. Taking it that the volumes of traffic are in the proportion 1 : 1.5 : 2, the result is shown in the diagrams of figure 7 : A B C for the total costs and A′ B′ C′ for the costs per unit of transport.

d) As regards the operating balance sheets, the replies received do not supply, on the whole, any precise trends. On most railways, the average cost of the train-hour has not been calculated and on the other hand, it also appears that the cost of stopping any type of train varies within very wide limits (according to the method of traction, the type of engine, the composition of the train, conditions on the line, etc.) to be able to give any good average values. It is certain that those factors which are the most difficult to calculate in comparing the operating for different arrangements of a line, are the numbers of train-hours or the numbers of stops and starts to be provided for with each of the solutions under consideration.

For these reasons, together with the fact that most of the installations carried out are some years old, we have no precise data for comparing the operating of the same section with two, three or four tracks, on the basis of the expenditure

relating to the train-hours, number of stops, etc.

Moreover, the number of train-hours determines the train staff costs and the rolling stock required. But these costs are not proportional to the number of train-hours owing to the fact that, especially over short runs, a difference in the journey time cannot have any appreciable effect upon the use of the staff and the stock.

e) Finally, the economies in staff due to modifications to the station and signal box staff are linked up above all to the fact that there is or is not automatic block installation, centralisation in the stations and C. T. C., and naturally vary considerably according to the number and size of the stations and signal boxes.

* * *

Although the data collected during this study do not make it possible to formulate for all the items examined any very definite and precise conclusion, we will indicate in the latter part of this Report the general conclusions possible as regards the examination of the traffic and installations, the establishment of the essential factors of the economic balance sheets, and finally the selection of the most rational solution.

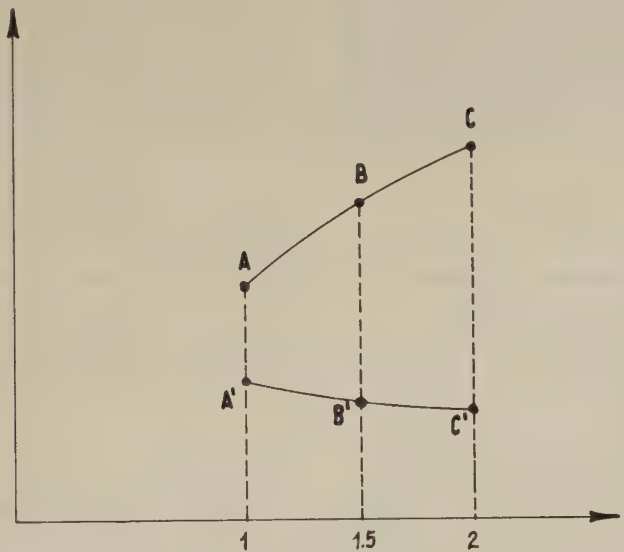

Fig. 7.

V. Consequences of adopting a third track with common user on the conditions normally laid down for the safety of train movements.

On this subject, the Railway Administrations gave in their replies some information about their signalling systems and safety regulations.

In the field of signalling and of safety regulations it must be stressed :

— almost without exception, the Administrations concerned use, at least on the more important lines, home signals preceded by distant signals giving the braking distance;

— on most of these railways all the trains, including goods trains, are equip-

ped with automatic brakes; on certain Railways, there is an exception to this rule in the case of a few trains running at low speeds;

— some of these Administrations have already introduced, at least on the main lines, or in the case of the trains running at the highest speeds, devices repeating the signals in the locomotive cab or at any rate automatic devices braking the train.

It is certain that operating regulations to avoid the danger of side on collisions when various trains and rakes are on the move at the same time in a station, depend essentially upon the value to be given, or that can be given according to the installations and equipment in the stations and on the trains, to the basic principle that the drivers must respect the signals absolutely.

Certain Administrations, whilst laying down in their regulations that the drivers must respect the signals absolutely, consider that other precautions must be taken in order to make good, to some extent, the consequences of any running past a signal at danger. This is why, for example, these Administrations consider it necessary to stop all movements beyond the normal stopping point of the train when a train has to make a stop in a station. Overlap distances are laid down in principle for this purpose from the departure signals and any train or shunting movement which might interfer with the overlap-section of the track on which the train arrives at the station is forbidden.

The length of the overlap-section varies according to the different regulations and characteristics of the stations.

The modern tendency is to reduce to the minimum the length of this overlap-section and to dispense with it in certain cases. Certain Administrations are in favour of doing away with it, in order to avoid the hindrance it causes to the train movements and station services.

The addition of a third track with common user to a double line (fig. 8); has evidently as consequence the increase of the number of cases of interference with itineraries and, in theory, the risks of side on collisions. Making « fly overs » is only possible at certain points of the line, especially in connection with branch lines (fig. 9) and certain connections between successive sections of line with a different number of tracks.

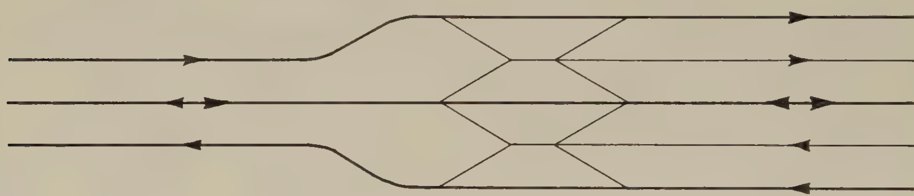

Fig. 8.

In principle, the installation on the lines and on the trains of equipments capable of regulating perfectly the running of the trains and assuring absolute respect of the signals is the best solution.

It will become even more necessary when the working of the line is not controlled locally owing to the introduction of centralised control (C. T. C.).

As regards the basic systems for assuring the safe running and regulation of running of the trains, on a line with heavy traffic where there is a third track in common user, it may be stated, in principle, that the automatic block and centralised control are preferable, and

that their application will be the more useful, if the use of the tracks depends on current operating requirements.

VI. Summaries.

1. *Characteristics of the traffic to be considered when studying the different solutions capable of increasing the capacity of a double line.*

When on a double line with very heavy traffic, it has become necessary to increase the number of trains, or to improve very substantially the operating conditions, it is obviously necessary to examine preliminarily all possible ways of increasing the capacity of the double line. With this object in view, it is possible, if this has not already been done, to introduce the automatic block, to improve the station track installations, to equip these stations with centralised control of signals and points, to make the maximum train speeds over the line uniform, to install a very complete signalling system in order to guide the running of the trains in such a way that the full possibilities of the line are made use of. If all these measures have already been introduced on the line, or if the whole of these measures are not considered sufficient to meet operating requirements, the advisability of introducing common user of one or both tracks should be examined, which in principle will include the installation of centralised control of signals and points. However, the efficacity of this system is linked up with a traffic involving periods of a certain lack of balance in the two directions of services either in the number of runs or in the length of time the track is occupied : since there are still only two tracks available, it is necessary that traffic peaks occurring in one given direction, shall coincide with very little traffic in the other direction for a longer or shorter period.

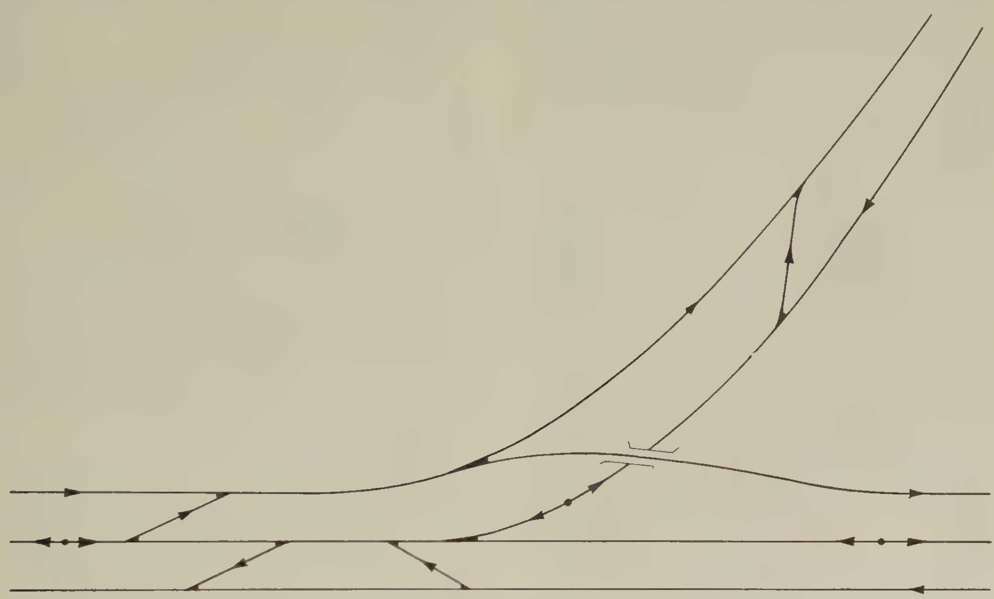

Fig. 9.

When on account of a very high traffic level or because of the characteristics of this traffic, common user will not prove an effective remedy, it is necessary to consider the usefulness, from the three points of view of operating requirements, technical necessities and economics, of introducing one of the two possible solutions : « making a third track with common user » or « having four tracks ».

From the point of view of operating requirements, these two solutions have a common part — one track specialised for each direction of traffic, making it possible to cope with the same basic traffic; it is therefore only the traffic over and above the maximum capacity which must be taken into consideration for the comparison.

If traffic peaks each largely exceeding the capacity of the line occur at the same time in both directions, « four tracks » is in principle the best solution. A third track with common user would only relieve congestion over a relatively short area, and it would be necessary to have proper crossing points on this track just like on a single track.

The position is different when a section of a double line has to cope with an equal number of trains in both directions, but for example owing to a steep gradient it takes longer to travel up than down. In such a case the third track would be used above all for the up gradient traffic; common user of the third track would serve no object unless relief was also required in the other direction at times when the traffic up the gradient could be moved on a single track.

In general, when the traffic is out of balance owing to peaks exceeding the capacity of a track but occurring only in one direction at the same time, the making of a third track in common use is an excellent solution from the operating point of view. In fact, on the one hand, the common use of the two tracks is not sufficient, as during a peak period there is a certain amount of traffic in the other direction, and on the other hand, the making of « four tracks » is not essential.

On a « three track » section it is sufficient, in principle to have common user on one only, so that two tracks could be used for one direction of running alternatively; the extension of common user to more than one track does not seem to be of practical interest, except in altogether exceptional operating conditions.

As regards the characteristics of the traffic in the same direction, the line may be one on which there are groups of trains running more or less parallel, for example on common sections of tracks in the vicinity of big towns, with alternate traffic peaks in the morning, at midday and in the evening, or mixed traffic of trains at very different speeds.

In this latter case, a third track makes it possible for the fast trains to pass the slow trains during their run. This can happen in one direction of running only if the third track is not in common use, or if it is, in both directions at different times. Only four tracks will enable it to be done in both directions at the same time.

Concerning the output of the line, the four tracks in principle double the capacity of the double track line. For « three tracks », the degree of increased output is closely bound up with the characteristics of the train services using the third track and vary according to whether, during the day, there are groups of trains at short intervals in the same direction (the most favourable position for high output) or many trains in both directions, which in practice leads, on the third track, to all the troubles experienced with single lines. For this reason, the increase in capacity in the case of three tracks can only be estimated according to the different situations existing and by approximation, and in certain cases, can reach, in practical working, a level of more than half of the existing capacity of

the line, owing to the fact that it is possible to distribute judiciously between two tracks the fast and slow services.

In principle, on three track sections, it is necessary to move the trains quickly from one track to the other according to the circumstances and, if needs be, to have trains passing each other on the track in common user just as on a single line, so that there must be a very fast and precise regulation of the traffic on the three tracks, as this alone will allow of sufficient flexibility of working, which in turn will be translated by a further increase in the real traffic capacity.

2. *Examination of the characteristics of the installations.*

As regards the characteristics of the installations for equipping a third or fourth track, the following two cases must be distinguished :

— that where the additional track or tracks must form in fact a distinct line, from the point of view of user, by the side of the existing double line;

— the three or four tracks of the converted line must form a single unit and deal with the traffic as a whole, the use of the different tracks being regulated according to operating requirements at any given moment even in departing from the agreed programme.

In the first case of two distinct lines, once the number and the kind of trains to be run on each line according to a predetermined programme have been determined, the installing arrangements will be studied according to the characteristics of the traffic belonging to each line, mixed user of the tracks being exceptional. The solution of four tracks is generally suitable to this latter system of use of the tracks, a few trains passing from one track to another may be considered sometimes inside a station, but their number will be kept as low as possible, to avoid interference with the itineraries of other trains in the station.

In the special case in which on a section of line with four tracks mixed user of the two tracks in the same direction, according to momentarily operating requirements, is normally required, in the section concerned, it is advisable to have the two tracks for the same direction side by side and make use of fly overs if necessary at the ends of the section.

The solution « three tracks » may be used in either of the above two cases (specialised or mixed user of the tracks). The third track at one side may be preferred in particular cases, if there is a tendency for its use to be specialised for given trains. On the other hand, a centre third track in common use lends itself more readily to operating needs when mixed user of the tracks according to temporary movements of trains has to be provided for.

In this latter case, in particular, it is necessary to cut up the line into independent sections so as to be able to run the trains with « partial common user »; for this purpose, it is necessary to make links between the tracks by means of elongated points, so as to avoid having to make trains passing from one track to the other reduce their speed too much, but if possible keep to the maximum speed allowed on the less favoured of the two tracks in question.

The installation of sidings in the stations is necessary if it is likely that the trains will have to wait, in a suitable position close to the crossings.

At junctions, where the branch line with the track in common user might interfere with the itineraries of the trains, fly overs are generally made.

As the crossings onto the track in common user are places where the itineraries of the trains will converge, from the safety point of view, if they are to be frequently used, there must be the utmost confidence in the correct observance of the signals; for this reason, on lines with common user the realisation of a very complete and clear signalling system is

of the greatest importance for the drivers as well as the development of other equipment intended to make sure the signals are observed, such as cab signals or automatic stopping of the locomotives.

Finally, as it is necessary, with this type of operation over three tracks to avoid any loss of time in using whichever track is available, for determining the crossings of trains or for the train regulation in general, the automatic block and centralised traffic control (C. T. C.) which assures the maximum rapidity in carrying out checks and orders, should, in principle, be provided. With four tracks, on the other hand, except in quite special cases, there is no need for C. T. C. as interventions to regulate the train services are required less frequently.

3. — *The factors affecting the economic balance sheet.*

The ratios between the installation costs for the two solutions « three track » or « four track » naturally vary according to local conditions. To determine these costs and their ratio, there is on the one hand the particular geographical conditions to be taken into account, which may make the work very simple or else very complicated, and on the other hand the more or less complicated modifications required in the stations concerned.

It must be considered that with the « three track » solution in particular, if the track in common user is in the centre, important modifications may have to be made to the track arrangement and signalling equipment. As such modifications would have to be made on a line where the traffic is already very heavy, this may lead to an increase in the cost of carrying out the work. On the other hand, four tracks in certain cases can be projected and carried out with fewer modifications and less hindrance to the double line already in service.

According to the information supplied for the different concrete examples examined, the ratio of the cost of the two solutions varies from 0.6 to 0.85, but it must be remembered that in special cases the ratio may even fall below 0.5.

As far as the economic balance sheets for the operation of the line are concerned, the interdependence of the factors, which in practice come into play in the productivity and regularity of the operating, makes it very difficult to give any preliminary estimate for the expected results of one or other of the solutions under examination. One formula may be to draw up graphically for each of these solutions theoretical timetables according to traffic requirements and the possibilities of the installations, and to compare the results, taking into account as far as possible the respective capacity for flexibility in the services when the trains run late.

From this comparison, theoretical data for the train hours may be extracted from which some idea can be obtained of the costs relating to the wagon-days, average traction-days, train staff, etc., not forgetting the practical requirements involved.

The costs of the station and signal box staff depend above all on whether or not centralised equipment is used in the stations, the automatic block and C. T. C., including telecontrol of the points and signals over the line. In the case of this latter type of installation, which in certain cases results in very substantial economies of station and signal box staff, account must be taken of the need to retain employees well spaced out who may be required if anything goes wrong. In general, the estimates concerning the cost of station and signal box staff can be worked out beforehand very accurately, for the different solutions under examination.

As regards the cost of maintaining the permanent way, sufficiently accurate estimates can also be made beforehand for the two solutions. Account must be

taken of all foreseeable requirements for staff and materials, according to the nature and arrangement of the installations and according to the $\frac{\text{total tonnes-km}}{\text{km}}$ and the $\frac{\text{trains-km}}{\text{km}}$ to be expected annually on each track.

With the above mentioned operating costs, and the capital costs (interest and sinking fund) a calculation of the total annual cost can be made for the two solutions under consideration and, finally, it is possible to estimate the cost per unit of transport and traffic fairly closely.

* * *

In concluding our study, we may ask the reason for the preference the Railway Administrations have generally shown to date for the solution « four tracks » instead of « three tracks and common user », although the latter is definitely the less costly.

On the one hand, from what we have said above, the « three track » solution can only be considered when the traffic peaks show well determined characteristics; even in that case the « four track » solution lends itself better to the preparation and maintaining of the timetables and naturally gives a higher output, which may lead to favour it from the operating point of view, especially if it is desired to make provision for a long term increase in traffic.

On the other hand, the fact that the European Railways have very restricted experience of the possibilities of centralised traffic control both from the operating and technical points of view, may also have led them to decide against the « three track » solution. In this connection, it must now be stressed that as a result of the technical progress made, the likelihood of a C. T. C. installation being accidentally out of service is extremely rare and this risk cannot be considered a sufficient reason for deciding *a priori* against the « three track » solution.

Finally, the choice between the two solutions can only be made after study of each particular case; the solution « three tracks and common user » may be preferred in certain cases where the characteristics and the importance of the traffic lends itself thereto, especially when the cost of making four tracks would be very high on account of geographical conditions; this is the case for example :

— for common sections close to large cities where traffic peaks occur in one direction only at different periods (morning, midday or evening) and where the cost of land is extremely high, or where making four tracks would involve making big embankments;

— for sections of a four track line, across large bridges too expensive to enlarge to take four tracks, with traffic characteristics suitable to three track working.

In conclusion, « three tracks and common user » may be used in the future much more frequently than in the past, its field of application to lines with very heavy traffic being however limited to fairly short sections with special characteristics.

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Diesel hydraulic twin railcars for Mexico,

by Obering. F. Kress, Salzgitter-Lebenstedt.

Several twin Diesel-hydraulic railcars for a Mexican Railway, which were completed some time ago, have proved extremely interesting to all those who present Mexican constructional requirements by « Waggonfabrik Linke-Hofmann-Busch A.G. » of Salzgitter-Watenstedt.

took part in the tests on the line because of their type of construction and their running qualities. These twin railcars were built, in accordance with modern technical progress and conforming to

The design of these vehicles was carried out under the following conditions : the twin sets had to be capable of carrying 104 passengers in first-class compartments at a speed of 120 km/h (74

m.p.h.) on level track; they had to be capable of non-stop journeys of a total distance of approximately 800 km (500 miles), part of which was through virgin forest; the stations have no platforms. On account of climatic conditions (from + 38° to — 5° C. with heavy humidity), it was impossible to use wood for the interior furnishing of the cars and the whole of the steel used for plates and rolled sections had to contain 0.25 % of copper. In addition, the separate units of the twin sets must be so designed that they could be used as motive units for hauling passenger carriages.

Each unit is mounted on one two-axled driving bogie and one carrying bogie which also has two axles.

The sets are in service on the Ferrocarriles de Sureste (South Eastern Railway). The line has an altitude of 300 m (984 ft.) and temperature varies between — 5° and + 38° C.

The following gives a detailed description of a twin railcar for Mexico.

I. Main dimensions.

Total length of twin set between end walls	52 360 mm (171′9 7/16″)
Length of body of each unit	25 795 mm (84′7 1/2″)
Width of body between end plates	3 100 mm (10′2 1/16″)
Height of coach from rail to crown of roof	4 120 mm (13′5 7/8″)
Height of floor above rail level	1 280 mm (4′2 13/32″)
Spacing of bogie pivots on each unit	18 795 mm (61′7 7/8″)
Wheelbase of driving bogie	3 600 mm (11′9 3/8″)
Wheelbase of carrying bogie	3 000 mm (9′10 1/8″)
Track gauge	1 435 mm (4′8 1/2″)
Diameter of wheels on tread	900 mm (2′11 1/2″)
Weight of twin set in working order	134 t
No. of seats, luggage car	52
No. of seats, kitchen car	56

Fuel, water and sand carried by a twin set :

Fuel (1 150 kg per car)	2 300 kg (5 070 lbs.)
Drinking water in kitchen car	400 l (88 gall.)
Non-drinking water in kitchen car	500 l (110 gall.)
Drinking water in luggage car	300 l (66 gall.)
Non-drinking water in luggage car	300 l (66 gall.)
Water for air conditioning (650 l per car)	1 300 l (286 gall.)
Sand (240 kg per driving bogie)	480 kg (1 058 lbs.)
Reserve sand in the set	300 kg (661 lbs.)

II. Motors.

Each car has its own motor installation, electric generator and air compressor.

Motor installation : the traction motors are Maybach-Diesel, type MD 320, six cylinders, four-stroke, with a nominal power of 450 HP and a speed of 1 700 r.p.m.

The Maybach-Diesel engine is bolted to a box frame and this is mounted at three points in the driving bogie, so that the cardan shafts connecting the Diesel motor to the Mekydro transmission, which also has a three-point mounting in the bogie frame, form an angle of 5° from the horizontal.

Between the Diesel motor and the Mekydro transmission is interposed a flexible link comprising a metallic disc, rubber mounted, coupling to prevent the creation of a critical speed in the motor equipment and also to insulate each group from the other's vibration.

The cooling of the Maybach-Diesel motor is done in a closed circuit, the same circuit serving for cooling the transmission and the motor oil.

The Maybach-Diesel motor is fitted with a regulator which works through an adjustable rodding on the injection control shaft and hence on the fuel feed. This regulator, built as a rotary speed controller, is electrically operated from the control desk in the driving compartment.

All connections to the Diesel motor are flexible.

To avoid risk of fire, a safety valve is fitted in the feed pipe of the Diesel motor, held open by a fusible ribbon located over the motor. If the temperature exceeds a pre-determined value, the fuse breaks and the valve closes through the action of a spring and the supply of fuel to the Diesel motor is stopped.

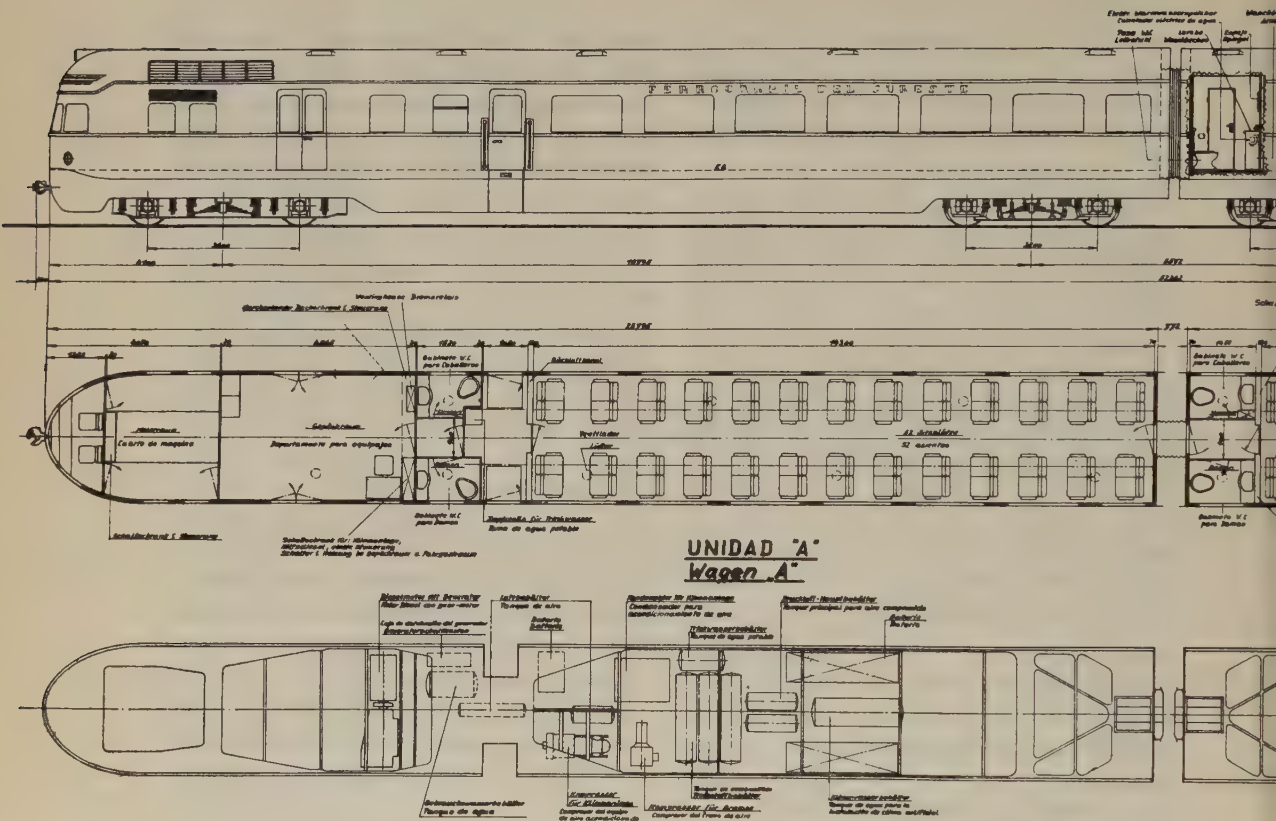
The exhaust gases from the motor are fed to an exhaust chamber and thence to the atmosphere. Suitable insulation and clothing of the exhaust chamber eliminate any risk of fire. Between the exhaust collector of the Diesel motor and the portion of the exhaust pipe fitted inside the engine room are two ball joints with a sliding sleeve to compensate for expansion of the exhaust pipe and also for relative movement when running over curves, between the Diesel motor mounted in the bogie and the exhaust chamber in the engine compartment.

Starting of the Maybach-Diesel motor is by dynamo coupled to the Mekydro transmission. It is stopped electrically by the regulator.

All parts of the Diesel motor are readily accessible from the inside of the engine compartment, which is a great advantage as the various auxiliaries have been mounted on both sides of the motor to facilitate inspection. In normal service, this concerns only the oil level indicator and the lubricant and fuel filters.

Fresh air for the Diesel motor is obtained from an air intake through a duct containing a Deulbag air filter conveniently located in an accessible position to facilitate periodical cleaning.

The Diesel motor drives a Mekydro-Maybach K. 64 type transmission com-

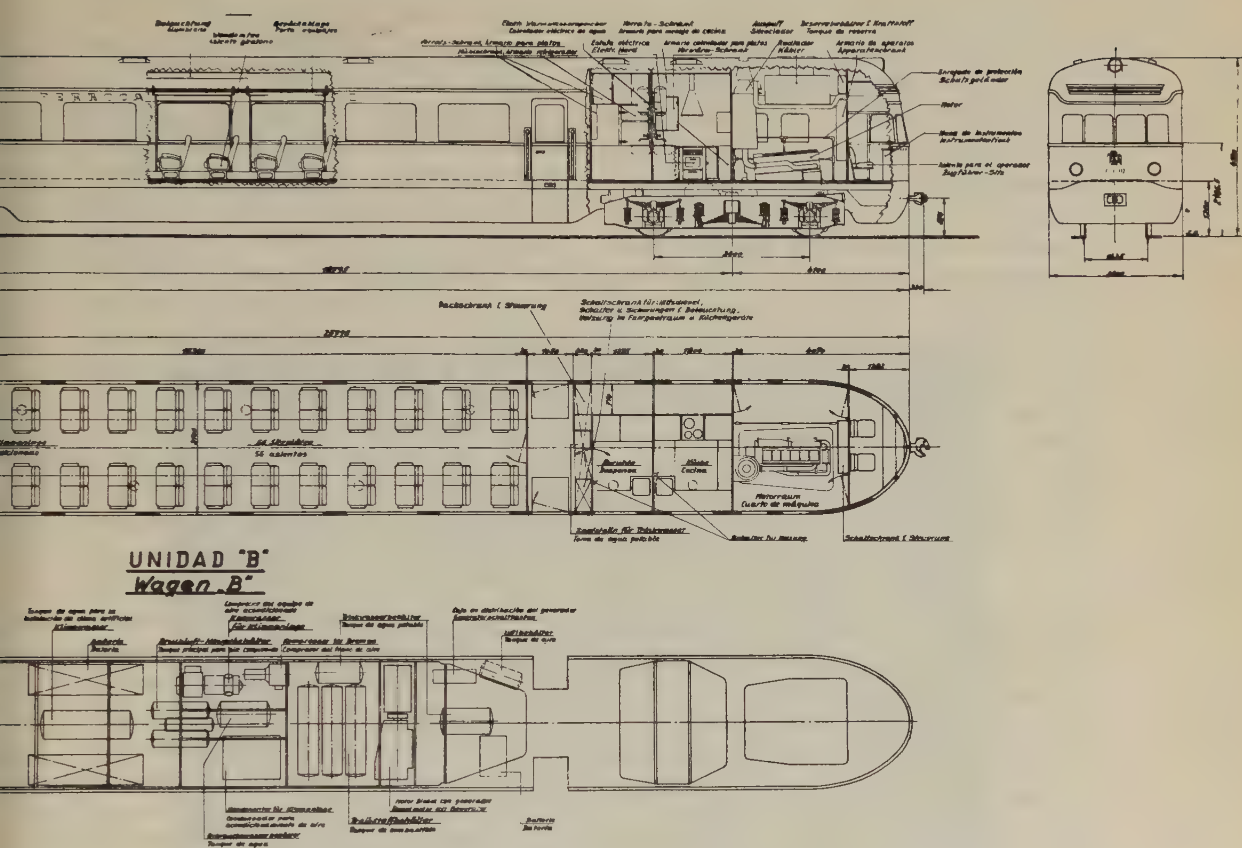


Elevation a

prising a four-speed mechanical gearbox with constant-mesh gears, preceded by a hydraulic torque converter, water-cooled. The transmission is provided with oil-pressure control which ensures the engagement of the different gear ratios in accordance with the running speed and power, by means of a Maybach-type claw clutch. A reverser incorporated in the gear box enables the direction of travel to be changed. An oil pump provides control pressure, torque-converter filling and gear and bearing lubrication. The water jacket for the torque converter is included in the Diesel motor cooling circuit.

The axles of each driving bogie are fitted with final drives operated by the Mekydro transmission through cardan shafts. The initial torque on the pinion shafts of the final drive reaches 900 kgm, and the transmitted power is 330 HP. These transmissions are of the C 22 type and comprise essentially a bevel gear reduction mounted in a two-part gear-case.

The cooling group constitutes a separate unit arranged immediately



of twin set.

beneath the ceiling of the engine compartment. Fresh air is drawn in by a fan located in the centre of a group of radiators, through lateral openings in the roof across the batteries of radiators arranged on each side of the centre line, and is expelled after absorbing heat through the roof.

This cooling group effects the cooling of the Diesel engine, the transmission and the motor oil. Between the radiator units and an equalising chamber in the engine compartment a thermostat has been fitted in the water pipe to control the operation of the radiator fan. The thermostat starts and stops the fan motor within specified temperature limits.

In each driving bogie there are also mounted the starting dynamo and an alternator.

The starting dynamo is driven by the Mekydro transmission through cardan shafts. When the Diesel motor rotates it operates as a generator. For this purpose it has been given a continuous power of 10 kW at 1 350 r.p.m. and then serves for recharging the main starting battery. When the Diesel motor is

stopped the dynamo is used to start the Diesel. For this operation it takes its current from the main starting battery.

The starting dynamo drives by belt a three-phase synchronous alternator of 36 kVA running at 3 200 r.p.m., which furnishes the current for the fan motor of the cooling group.

Each railcar has its own fuel storage with a capacity of 1 050 kg. The fuel is electrically pumped into three tanks arranged in the frame. It is fed to the Diesel motors at a pressure of about 0.6 atm. The excess fuel returns to the three main frame reservoirs via an auxiliary tank in the engine compartment which is preceded by an oil-pressure valve. If the fuel pump fails or the main tanks are exhausted, the Diesel motor can still run for a sufficient length of time at a reduced power with fuel fed by gravity.

The main fuel tanks can be isolated in the event of a defect. They are specially protected against impact from stones by plates in front of them; they can be filled from either side by compressed air and a hand fuel pump is located in the engine compartment for use if needed.

For supplying the air-conditioning, heating, kitchen equipment, drinking water filters and passenger compartment lighting in normal service, a three-phase Diesel alternator group has been located in the frame of each railcar. For preparation at the departure station, or even for long stops at intermediate stations, the three-phase system of the railcar can also be fed on the local supply by means of four-pin contacts. When the connection is made the Diesel generator can then be stopped.

For driving this generating set a Daimler-Benz Diesel six cylinder motor is used with a continuous power of 90 HP, running at a maximum speed of 2 800 r.p.m. It is mounted on the same bed as the three-phase group which it drives, and this bed is installed in the frame with a Getefo-Gimetall suspension. The fuel necessary for its operation is also taken from the main reservoirs. The radiator is located in the frame; the necessary cooling air is drawn across the radiator through a metal grill. A cooling water thermostat on the distribution panel of the luggage compartment or the entrance platform of the car controls the Diesel motor. This thermostat comes into action when the temperature of the cooling water exceeds a specified value, stops the Diesel motor and lights an indicator lamp on the two driving desks of the set. The thermostat is self-locking and the Diesel can only be restarted when the temperature of the cooling water falls below the maximum permissible value, because the thermostat can then only be returned manually to the working position.

The A. Van Kaick three-phase alternator driven by the Daimler-Benz Diesel motor is built for a tension of 127/220 volts. Its running speed is 1 800 r.p.m. and its power 45 kVA.

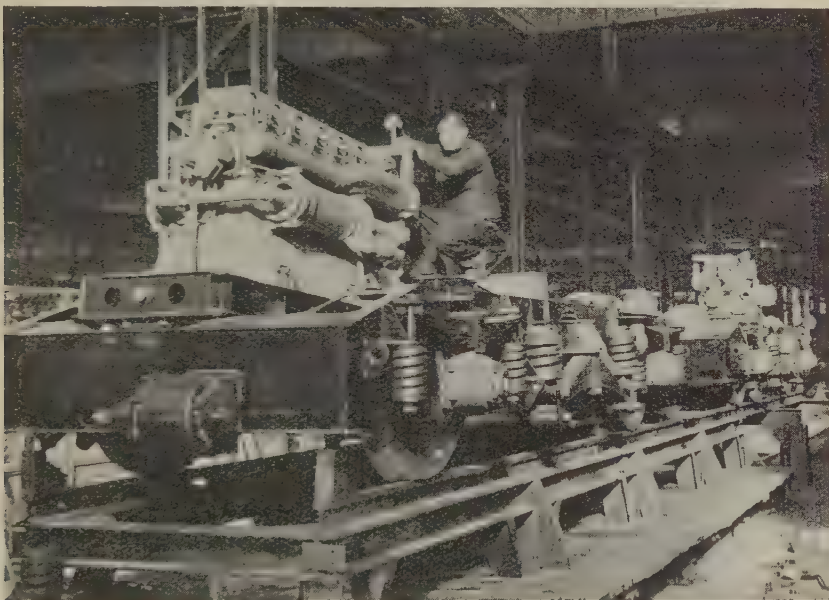
Compressed air for braking and water distribution is produced by a Knorr V 100/100 compressor mounted in each coach and driven by a GK 280 FK D.C. motor, running at 1 000 r.p.m. and consuming 6.5 kW. The two coupled groups are mounted on a common frame

which is also suspended from the main frame by a Getefo-Gimetall suspension.

III. Bogies, underframe and body frame.

Each coach is mounted on one driving bogie and one carrying bogie. The bogie frames are of heavy St 37-21 steel plate, all welded. All the wheel sets, manufactured by Bochumer Verein A.G. have disc wheels of St 42-11 steel with tyres of Siemens-Martin special steel. The axles of the driving bogies are of special alloy steel, heat-treated and the axles of the carrying bogies have a tensile of 65 kg after tempering. The wheel sets have SKF pendulum roller bearing axleboxes. Between the bogie and the swing bolster there is a quadruple suspension of laminated and helicoidal springs.

The driving bogie also carries the motor installation. The Maybach-Diesel motor is fixed to the frame by a caisson mounting which also has a three point suspension on the bogie. Also located in the driving bogie with three point mountings are the Mekydro transmission, the starting dynamo and the alternator. At each end of the driving bogie is a compressed air brake cylinder which operates the brake rigging to the brake shoes for the corresponding wheel set. Each driving bogie is provided with four sand hoppers, each holding 40 kg of sand. In addition, each driving bogie has a De Lymon rail lubricator, using pumped grease which is blown by com-

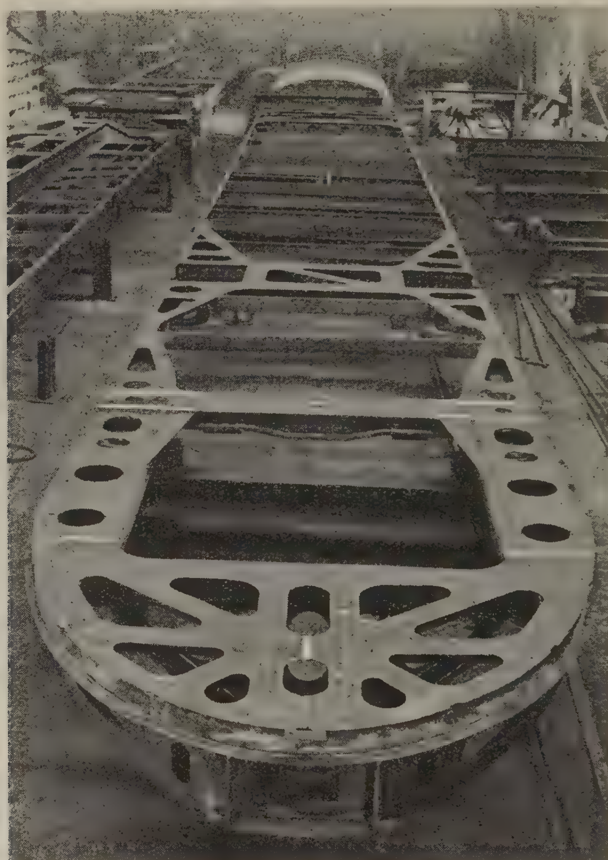


Driving bogie.

pressed air on the rubbing surfaces of the wheel flange root. The two tyres of the leading axle of the driving bogie are lubricated.

The carrying bogie is also provided with a magnetic rail brake, Knorr type.

The body underframe is constructed mainly of heavy plate, of St 37.21 steel containing 0.25 % copper, welded to form a monobloc unit. In a few isolated cases use has also been made of Mannstaedt rolled sections of St 37-12 steel.



Underframe of twin set.

The brake electro magnets are located one on each side between the two axles. Each carrying bogie has a brake cylinder which, as on the driving bogie, operates the brake rods to the brake shoes on each tyre.

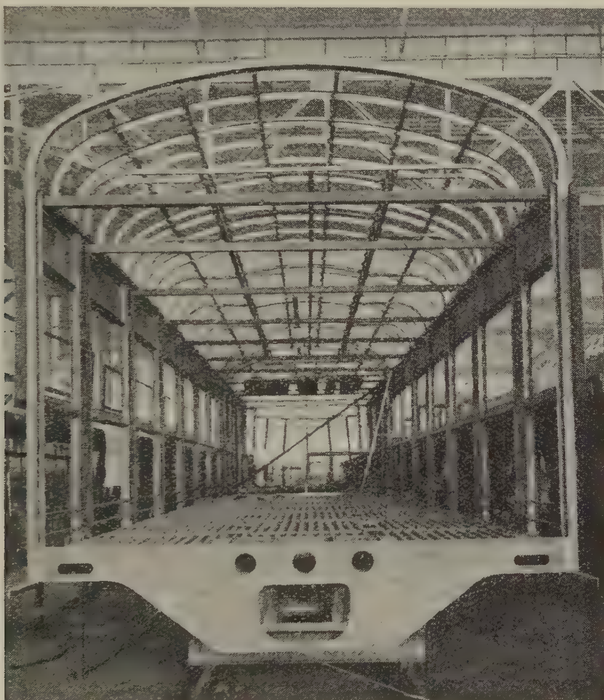
The upper surface of each frame is kept perfectly flat. Traction and buffing stresses are absorbed by Henricot drawgear and transmitted to the two longitudinals in the front end of the frame. In line with the entrance to the coach,

where the longitudinal frame members are cut away, the frame has been suitably re-inforced.

All the brackets for suspension of tanks and equipment are rivetted or bolted to the inner face of the frame to facilitate dismantling.

plate. All the parts of the body frame are welded to each other. The side walls and roof are separately fabricated on welding jigs and, when complete, welded to the frame.

The sides and ends are covered with 2 mm plate of St 42 steel containing



Body frame.

0.25 % copper. The plates are fixed to the framing by spot welding.

The caissons used for the construction of the frame have apertures suitably located to improve accessibility and provide ventilation.

The upper surface is covered with plate welded to it. The body frame is of the same steel as the underframe. The rolled sections are light Mannstaedt rollings and the mountings are pressed

The roofs are arched. They are made up of curved plates and longitudinal angles covered with 1.5 mm copper-bearing steel.

The sides form part of the loadbearing structure. The window frames are flush-mounted to reduce air resistance.

To the lower part of each railcar is fitted a casing, rigidly fixed to the body in front of the bogies and movable in the central part. A certain number of inspection doors in the casing allow ready access to those components mounted on the underframe which require special maintenance.

All the spaces between the inner and outer walls and between roof and inner ceiling are filled with insulating material which not only provides compartments with thermal insulation but also with a highly satisfactory degree of sound proofing.

The flooring is 10 mm laminated board, resistant to tropical climate, covered with 3 mm linoleum. The laminated board rests on an insulating layer of bitumen run into the various hollows of the corrugated plate and having 10 mm thickness over the higher parts. In the brake compartment there is a steel plate floor and the engine room has a ribbed floor.

IV. Compartments.

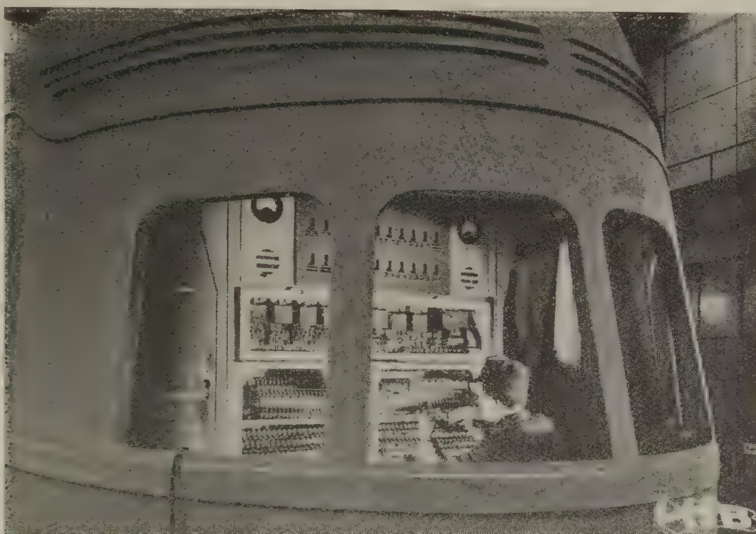
The luggage car is sub-divided in the following order : driving compartment, engine room, baggage compartment, ladies' and men's toilets, entrance vestibule and passenger compartment. Then comes the kitchen car, sub-divided into : ladies' and men's toilets, passenger compartment, entrance vestibule with side corridor, staff compartment, engine room and driving compartment.

Driving compartments : These are at the leading end of each car and have two seats behind the control desk. Four large fixed windows of Securit glass are fitted in the front wall to allow the driver perfect visibility of the line. The central portion is fitted with a sunglare screen, glass heater and wiper. Fresh air enters through the roof inlet slots across a deflector in the roof which directs it into the driving compartment by an adjustable inlet mounted on the ceiling. The driving compartment can also be electrically heated. It communicates with the engine room, which it adjoins, by two pivotting doors. The rear wall of the driving compartment is occupied by the distribution cabinet, in which are located behind a glass panel, all the various relays for electrical control, a ticker for the running control safety devices, a bell, various automatic equipment and the ammeter and voltmeter for the main battery. In the same cabinet is the car circuit breaker. By operating the end button of this circuit breaker, the car can also be used as a driving trailer.

On the driving desk are clearly arranged the control and indicator instruments for the motor equipment of the two cars and for the compressed air and magnetic rail brakes.

Engine compartments : As each unit of the twin railcar is provided with the same mechanical equipment, the engine rooms are identical. We have already noted that each Maybach-Diesel motor, its transmission, the starting dynamo and alternator are mounted in the driving bogie. The Diesel motor only projects into the engine compartment through a suitable opening in the floor. To avoid pockets of heat the Diesel motor is not covered. It has been found that even

when the set is running at high speed there is no draught in the compartment and consequently there is no ingress of dirt into the compartment through the motor aperture. Above the motor, under the ceiling, is installed the cooling group. In addition, mounted under the duct from the intake on the front wall. In addition, warm air is supplied by the exhaust gas from the Diesel motor in the pipe over the exhaust chamber; for this purpose it is provided with a specially designed system of tubing. The engine room is lighted by lamps in ceiling and



Working on the control cabinet in the driving compartment (rear wall).

ceiling there is a collecting tank for the cooling water and a reserve fuel tank with a capacity of 100 l (22 gall.) Hand pumps with corresponding feed pipes are provided for filling the corresponding water and fuel tanks. In principle, water and fuel are, however, supplied to the tanks by compressed air.

The engine room is painted with fireproof paint. It communicates with adjacent compartments by pivoted doors.

The engine room is ventilated by means of air intakes in the side walls above the windows, and by a fresh air wall fittings. The oil fuel level indicator of the auxiliary tank and the water level indicator of the collector are directly illuminated.

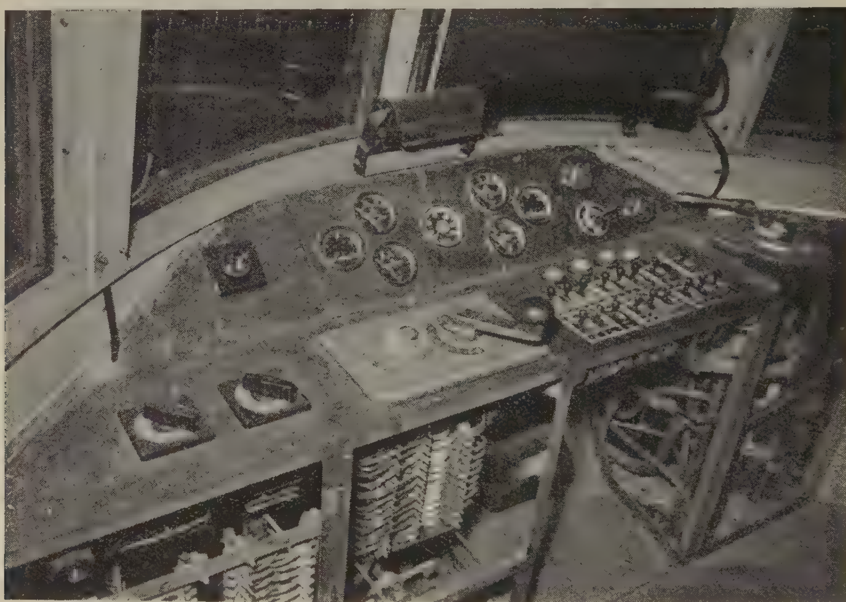
Toilets : Separate toilet accommodation is provided for ladies and men. They contain a table and wash bowl with hot and cold running water, a wall mirror and towel holder and a flush lavatory.

Each toilet compartment is painted in white gloss and the floor is of harmoniously coloured ceramic tiles. They are provided with wide drop windows electric heating and roof ventilators.

The toilet compartments are provided with roof lights, the wall mirrors can be separately illuminated by means of special light fittings on each side of the mirror.

Entrance vestibules : These are reached directly by opening the outer doors and setting the steps. Since the Mexican Railway stations have no platforms, it is necessary to install folding steps to allow the passenger convenient entrance to the coach from ground level. Before departure the steps are folded in such a way that the side walls are unbroken. On the vestibule itself, the folding of the steps automatically closes a cover for the steps. The folding and unfolding of the latter is very simple and easy. The steps are automatically locked in the two extreme positions This lock must be released before the steps can be moved.

The very large vestibules, decorated in an identical fashion to the passenger compartments, include an alcove for the electrical equipment of the drinking water cooler, which is of American construction, and provides ice water for the passenger on pressing a spring button. In the alcove there is a paper cup dispenser. In the same alcove, there is a special arrangement for disposal of used paper cups.

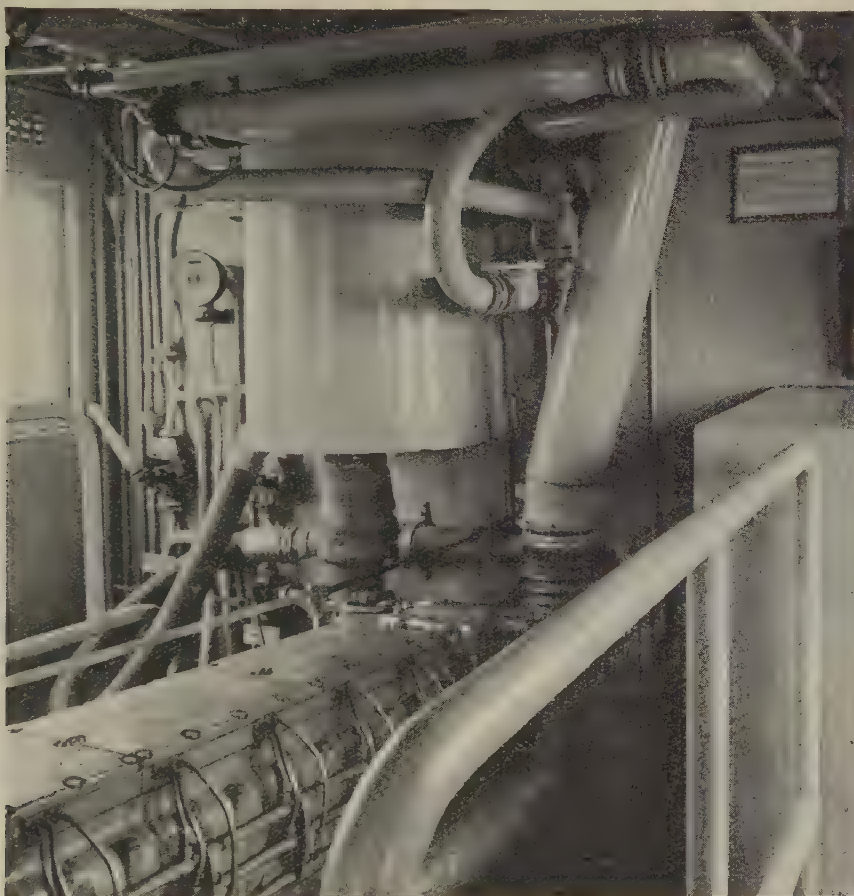


Driving table in course of equipment.

The vestibules are illuminated by ceiling fittings.

Passenger compartments : Because of the long distances to be covered by the twin sets, great attention has been paid

to the comfort of passengers. The passenger compartment of each coach is provided with particularly wide windows of Securit glass to ensure a large field of vision. The compartments have sleeping. Seats and backs are trimmed in red, the seat frames are of light metal. In the arm rests are removable ash-trays. In addition, each arm rest is drilled to allow a table to be fixed. These tables



Engine room.

American type rotating seats which allow the seats to be turned in any direction in relation to the centre line of the car. In addition, the back rests can be set in three different positions so that the passenger can conveniently recline for are stored in the car and when fitted they allow the passenger to take meals and drinks without leaving his seat.

The seats are numbered to allow the passenger to reserve in advance any desired place. In addition, a space is

provided under the number for insertion of the passenger's ticket.

Timber was not permissible for the interior equipment of the passenger compartments and the interior has therefore been finished with 1 mm plate. The inner walls are covered from the window sill moulding to the roof moulding with very heavy grey tapestry. From the floor to the sill moulding they are covered with 3 mm Trolonit. The ceiling is painted in cream lacquer and the floor is grey linoleum, with red-grey overall carpet. All the windows are fitted with blinds. The mouldings are anodised aluminium.

Along the centre line of the compartment roof is a luminous fitting having eight 25 watt. filament lamps per meter which, by indirect radiation ensures particularly efficient compartment lighting. On each side of the light fitting are the masked orifices of the air conditioning equipment to introduce hot or cold air into the passenger compartment, this being extracted through apertures in the lower part of the partitions. By means of this arrangement there is a favourable air circulation.

To complete the air conditioning installation, there are in the roof three motored fans and three ventilators. In addition, along the lower part of side walls there are provided electric radiators.

Along the two sides above the windows are parcel racks of polished hydronalium.

To avoid interference with the perfect operation of the air conditioning installation, all windows on the side walls of each passenger compartment are fixed and the hinged doors have automatic closing.

The compartments are tastefully decorated and offer a satisfying ensemble.

Luggage compartment : This has a loading area of about 12 m² (129 sq. ft.) and provides both for baggage and accommodation for the train conductor. For the latter purpose there is a folding table and seat near the side window. The toilet partition wall has distribution cabinets for the electrical control starters, auxiliary Diesel and lighting and heating switches. On this wall there are also clothes and tool cupboards. In the baggage compartment the conductor also has an emergency brake valve. The two double doors of the luggage compartment, like all the other doors of the sets, open inwards. The whole of the baggage compartment is painted in a grey shade.

Kitchen and staff room : These are provided in the coach which has no baggage compartment. The staff room has a hinged door to the vestibule and one to the kitchen. These two compartments are painted white. The windows of the two compartments can be lowered and the extraction of stale air is by roof-mounted fans. Lighting of the compartments is by roof fittings.

The kitchen is equipped with an electric cooker having three hotplates and an oven. Each of the three hotplates and the upper and lower heating elements can be regulated to give three stages of heating. Above the cooker is a fume extraction chimney. An electrically-heated cabinet is provided with sufficient capacity for hot dishes and drinks.

On the walls of the kitchen are cabinets at table level and also above the tables covered with stainless steel sheets. Other cupboards on the partition walls provide accommodation for kitchen equipment and provisions. A sink is provided, with hot and cold water.

Passenger compartment.

The floor is covered with removable wooden duck boards. A drain pipe through the floor provides for disposal of washing water. In the door to the staff room is a serving hatch to allow dishes to be passed through without opening the door.

The staff room, which also has working cabinets, wall cupboards and a sink with hot and cold water supply, is also provided with an electric refrigerator of American manufacture.

Air-conditioning installation : At the request of the Mexican Railway authorities, the coaches of the railcar sets have been equipped with the American « Safety » system of air conditioning. This is a separate unit for each coach and has the task of providing a sufficient quantity of air for each passenger compartment. The air introduced is made up of about 25 % of fresh air and 75 % recirculated air. Fresh and re-used air is filtered and before introduction into the passenger compartment is heated or cooled according to the external conditions of temperature.

To heat passenger compartments when outside temperatures are low, basic heating is provided in all compartments except the engine room. The air con-

ditioning is based on the principle of heat transmission by a vapourising liquid. The liquid used for the purpose is Freon F 12. The circulation of the coolant is controlled by the system. This comprises a tank for the liquid, expansion valves, the evaporator, the condenser and suitable piping.

The evaporator in the air conditioning equipment is located over the ceiling of the ladies' and men's toilets and the separating corridor. Fans draw the mixed fresh and re-used air into the heating or cooling coils, where it is cooled and dried or heated as required. Following this the conditioned air is directed into the passenger compartment by inlet ducts. A part of the ambient air of the compartment is extracted by fans and ducted through the partition to a mixing chamber where it is mixed with fresh air. The mixed air is passed through filters, its composition being controlled by louvres. The circulated air and fresh air louvres can be operated from the vestibule. Another part of the used air is discharged to the atmosphere. The cooling coil of the evaporator is in two parts and each part is fed with cooling fluid by its own expansion valve. This arrangement allows it to be worked at about half-capacity when the outer temperature does not call for full cooling. A trough below the evaporator collects the evaporation moisture which collects on the cooler coils.

The compressor set includes the compressor itself, the coupling and the electric motor. The compressor is V shaped and oil lubricated under pressure. The driving motor has two speeds so that it can work at half-power when the demand for cooling is not great. The compressor set is borne by the underframe by a robust framework mounted on rubber pads.

In this installation a water cooled condenser is used. Cooling is obtained by evaporation of water atomised by compressed air directed on to the condenser coils. This condenser is encased. The various coils are separate and laid horizontally. An atomising pump, at the end of the case draws water through a filter and directs it to the spray head mounted above the coil. The water flows over the condenser and returns to the tank at the bottom of the case. The fan forces air through a filter in the front of the case and blows on the coil. The tank and fan are mounted separately.

On the distribution panels of the luggage compartment and of the entrance vestibule are the control, starting and stopping equipment for the compressor, condenser fan and pump motor. The distribution equipment comprises progressive starters for the compressor motor.

In the coaches themselves, the control panel of the air conditioning installation has been fitted by the « Vapor » firm. This panel carries the starting switches for the control gear and thus for the whole of the air conditioning equipment, as well as the necessary relays.

The conditions under which the air conditioning installations must operate are not uniform. The outside temperature varies and the need for cooling also varies according to temperature and the number of passengers.

The speed of the various motors varies

with the tension. All the combinations of variation have an undoubted effect on the operating characteristics of the equipment. At the same time, tests in service have given extremely satisfying results.

V. Electrical control.

The electrical control gear allows each coach to be worked separately, as well as in the form of a twin set. The twin set can be driven from either of the driving cabs. The two coaches of one set are connected by screw couplings and electric couplers. According to requirements the set can be worked by both motor units or by a single one. In the event of one motor unit failing, the twin set can be worked from the corresponding cab by moving the main switch to the « driving trailer » position. If, however, the motor unit fails in the vehicle with the vacant cab, the driver can, by placing the switch in the « control » position, test the operation of the motor unit from the other cab without affecting normal operation.

The electrical control as well as all other electrical equipment of the rail cars has been carried out by Brown-Boveri.

For starting the Diesel-Maybach motors, special steel-cased accumulators are used, manufactured by Mareg-Akkumulatorenfabrik G.m.b.H. Each battery is made up of 88 Mareg type nickel-cadmium cells with a particularly low internal resistance. The battery used, type TS 225H, has a capacity of 225 Ah. The charging potentialities of this type of battery ensure perfect starting of the motors.

The Daimler-Benz Diesel motors are also started by a Mareg steel-cased battery. This, type TS 90 H is made up of 20 cells and has a tension of 24 V.

The D.C. generators of each car supply :

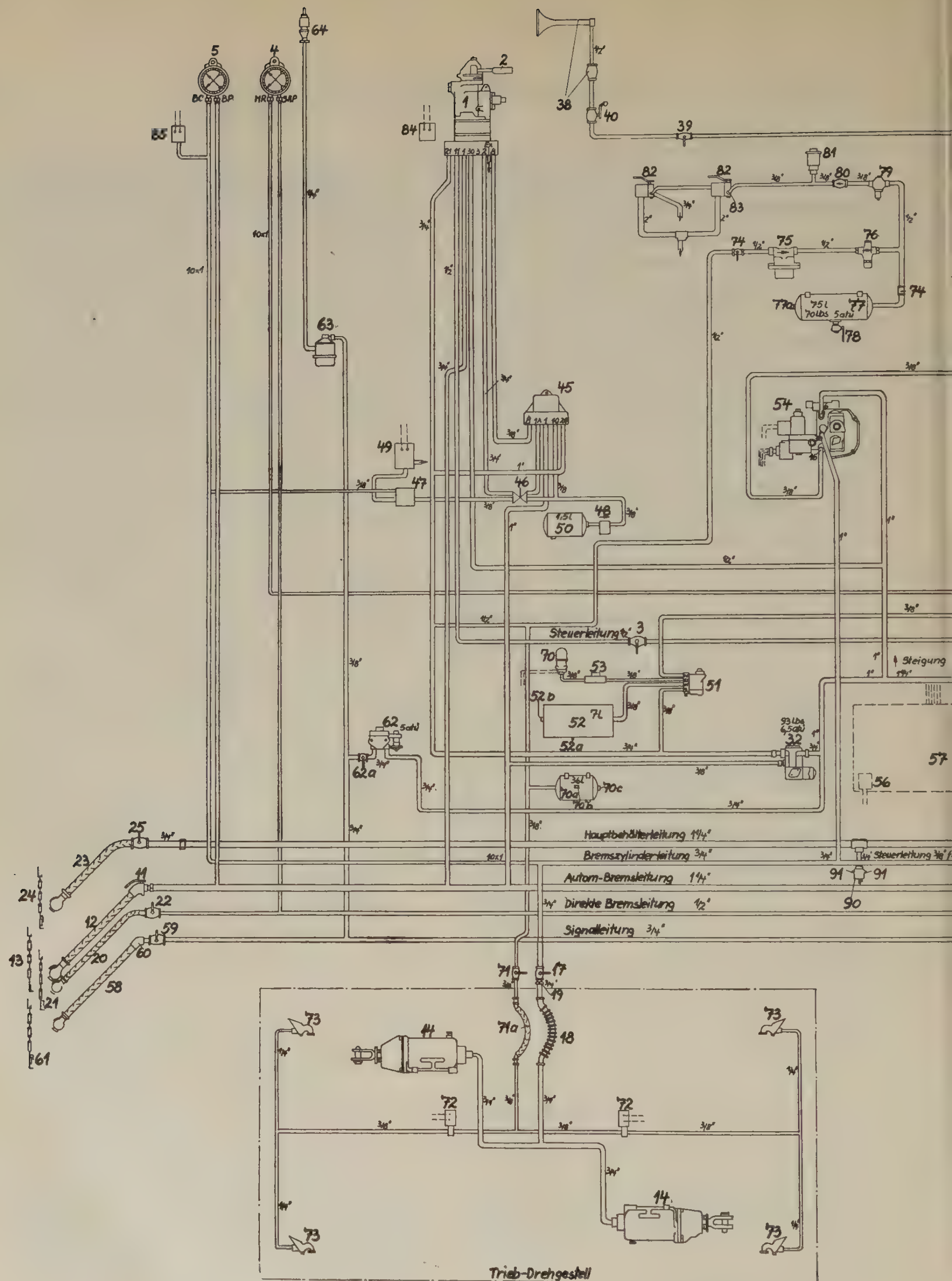
1) the driving control gear;
2) the Diesel motor and transmission indicators;
3) the main lighting and emergency lighting;
4) the motor driven roof ventilators;
5) the water heaters for the toilet compartments.

The setting of the controller controls the direction of travel and gives six different Diesel motor speeds.

Notch 0	Diesel engine speed is	600 r.p.m.
1	» » » »	600 »
2	» » » »	1 000 »
3	» » » »	1 200 »
4	» » » »	1 400 »
5	» » » »	1 550 »
6	» » » »	1 700 »

Two other contactors serve for starting and stopping the 2 Maybach-Diesel motors.

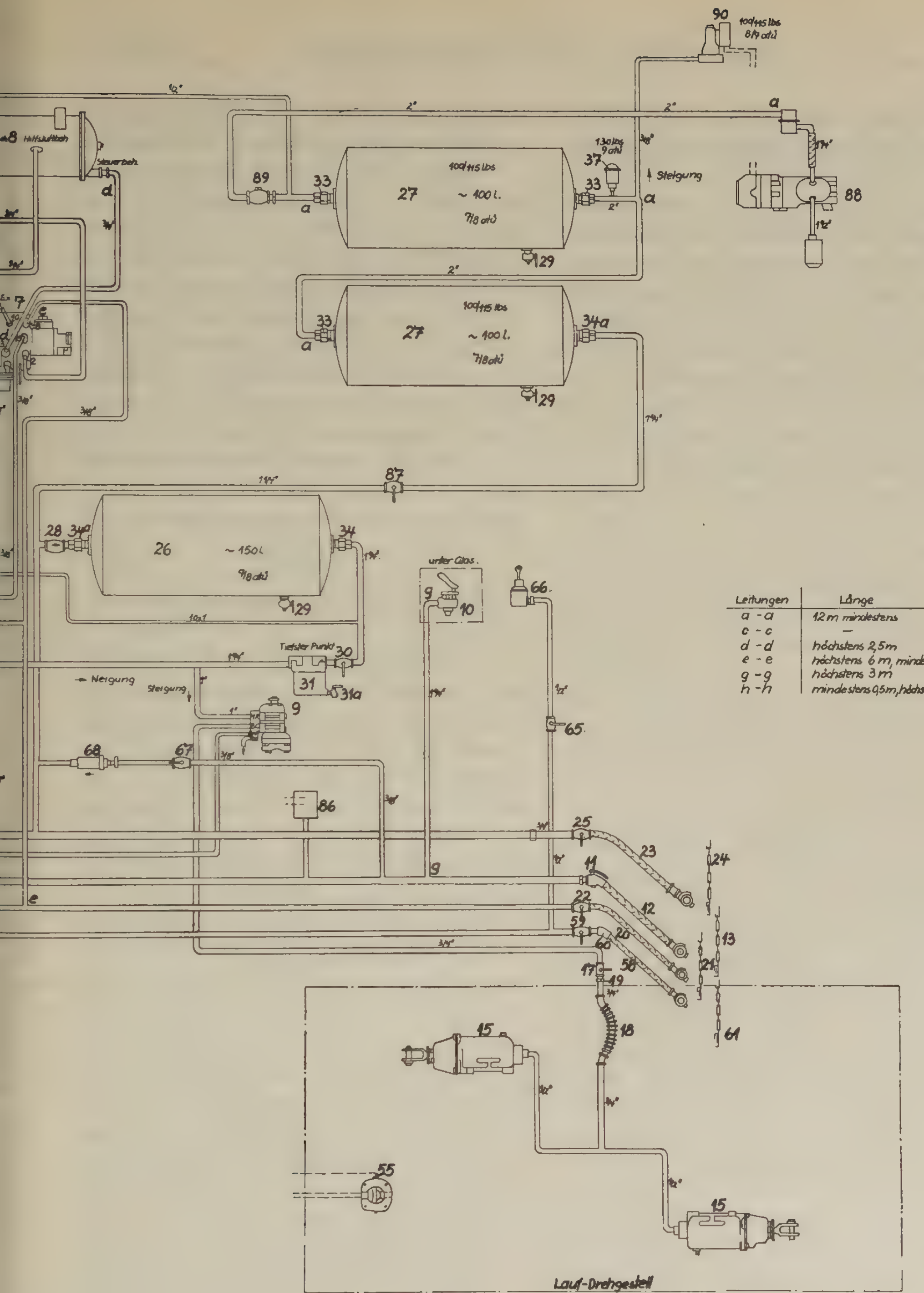
The temperature of the cooling water for each Maybach-Diesel motor is indicated on each control panel. Oil temperature is indicated in an identical manner. Absence of oil pressure in the transmission is notified by means of an indicator light on the driving table. If



HSC brake equipment for twi

Explana

Steuerleitung = control pipe. — Hauptbehälterleitung = main receiver pipe. — Autom. Bremsleitung = automatic brake pipe. — Dire
bogie. — Relaisventil = relay valve. — Tiefster Punkt = lowest point. — Notbremsebeh. = emergency brake reservoir. —



Leitungen	Länge
a - a	12 m mindestens
c - c	—
d - d	höchstens 2,5 m
e - e	höchstens 6 m, mindestens 3 m.
g - g	höchstens 3 m
h - h	mindestens 0,5 m, höchstens 1 m.

ghouse Brake Co., Hanover.)

terms :

= direct brake pipe. — Signalleitung = communication pipe. — Triebdrehgestell = driving bogie. — Lauf-Drehgestell = carrying
auxiliary air reservoir. — Leitungen — Länge = pipes — length. — Höchstens = maximum. — Mindestens = minimum.

the oil temperature exceeds a fixed value the corresponding Diesel motor is stopped.

Each Maybach-Diesel motor has a revolution counter which operates a speed indicator. When the Diesel motor has reached its free running speed, the cooling water circulating pump is automatically stopped. The fuel pump operates when the reverser is set for either forward or reverse running. Similarly, the electrical control of the fan for the Maybach radiators is governed by variations in the speed of rotation of the alternator.

Should the main recharge battery fail the D.C. supply can be connected to the main starting battery of the other coach.

To ensure vigilance by the driver, the « dead-man's » handle must be applied permanently or at short intervals. The driver, however, may also use a pedal or one of the manual push buttons on the side of the cab if the car is running at more than 18 km/h (11 m.p.h.).

The bell systems in the two driving compartments also serve as a method of communication between them.

On the rear partition wall of each driving cab is an isolating switch which also allows the car to be used as a trailing vehicle. In this position, all motor equipment is isolated. In the case of failure of a car, the defective motor can thus be isolated. In the « control » position, the drive can be checked from the corresponding cab.

Lighting : The whole of the lighting as well as the emergency lighting of the passenger compartments, vestibules and all doors, is supplied by the car's direct current generator. A switch in the equipment cabinet of each car provides for connecting all passenger compartment lights to the D.C. generator. Sockets are fitted above each driving table, one serves for connecting a hot plate or heater and another for a second one if needed. Another socket, with a safety contact is located below the driving table for connecting a portable light. A similar take off point is provided in the luggage compartment and in the staff room. Each engine compartment has two sockets with safety contacts and special point for the roof-mounted gear.

VI. **Brakes.**

Each car has three independent brakes :—

1) Westinghouse HSC compressed air brake by the Westinghouse Air Brake Co. Wilmerding, specially designed for high speed railcars. It is supplemented by electrical control of brake force in relation to speed and, to increase safety, by a dead man's device. It can also be used, if necessary, as a compressed air brake for trailing vehicles;

2) hand locking brake, acting only on driving bogie concerned;

3) magnetic rail brake, Knorr type DD 135 on the carrying bogie of each railcar.

The Westinghouse compressed air brake is used as the service brake. The brake cylinders and rigging are in the bogies, the other brake mechanism, apart from the driver's valve and pressure gauges, being under the coach body.

The compressed air installation also provides pressure for the water system. Similarly, the sanding gear can be oper-

ated from the driver's cab using the compressed air. With emergency brake applications it operates automatically.

Since the railcars may work as two separate units, communication equipment is fitted in addition to warning signals to enable the driver to receive signals from the train.

Compressed air is produced by a Knorr VV 100/100 compressor.

As the units generally work as a twin railcar set, however, each unit has only one driving compartment. In the unoccupied cab the brake valve handle must be raised, and the dual isolating valve (46) must be placed in position II in which the driver's valve is isolated from the automatic brake and control pipes.

When the compressors are running, compressed air (see following figure) is supplied through the first part of the cooling coils into the first air receiver and through another coil into the second main air receiver. The air is taken through a $^{3}/_{4}''$ (19 mm) pipe into a third receiver provided with a non-return valve and from which it can be used only for braking. From this receiver, the air flows through the filter (31) to the relay valves B 3 (9) and F 1 864 (54).

In addition, the pipe supplies through the relay valve (51) the air receiver (52) for the automatic sander. Air pressure in the main receiver is indicated by a duplex pressure gauge (4). A certain amount of compressed air flows from the second main reservoir without passing through the non-return valve into the continuous pipe between the main receivers to balance the pressure in the receivers of the two vehicles.

High pressure air is also supplied to the feed valve (32), which reduces the pressure to 7.7 kg/cm^2 (109.51 lbs per sq. in.) and from there to the driver's valve. Some of the air at the reduced pressure is also supplied to the water system and feeds an air receiver having a capacity of 75 litres (77). In addition, it feeds the sanding gear electro-valves of the bogie (72) which are provided with a reserve tank (70*a*). When the pressure in the main air receivers reaches 10 kg/cm^2 (142.23 lbs per sq. in.), the air pressure regulator (90) stops simultaneously the Knorr motor compressors of the two cars. When the pressure falls below 9 kg/cm^2 (128.01 lbs per sq. in.), following the discharge of compressed air, the compressors are automatically restarted by the pump controller (90).

In the manned driving compartment the dual isolating cock is in position I so that the two pipes concerned are open. The handle of the driver's valve is released.

Because of this, compressed air passes to the feed valve (32) in the automatic brake pipe and from there to union 1 of the distribution valve (7) which feeds the auxiliary reservoir and the emergency brake reservoir to provide a supply of air for automatic braking.

The automatic brake pipe is tapped to the driver's brake valve (45) dead man's fitting and the tapping is closed by an exhaust valve. This is kept closed by the pressure of air, on the plunger of the valve, from the feed pipe through the exhaust electrovalve (40) and from the isolating valve C-2. At the same time, the retarding tank (50) is fed through the double non-return valve

(48). When the auxiliary and emergency brake reservoirs are filled to 7.7 kg/cm^2, the brake cylinders are kept under pressure by means of the relay valves F 1 864 (54) and B_3 (9).

The foregoing description of the method of operating the compressed air brake refers to supply and release whilst the following remarks will describe the direct brake operation.

If the driver of the car moves the handle of his brake valve from the supply and release position towards the braking position, compressed air from the feed pipe passes into the control pipe, feeds by the double isolating valve (46) the direct brake pipe and at the same time enters through the union 8 into the control valve 7 and by the union 16 of this passes towards union 16 of the relay valve (54) where it opens the valve so that compressed air can pass from the main receiver into the pipe to the brake cylinders. The pressure ruling in the latter pipe is exactly the same as that in the direct brake pipe so that by setting the driver's valve it regulates the brake within wide limits.

The relay valve B_3 (9) works in the same way as that numbered (54). The brake cylinder pipe from relay valve (54) serves as a control pipe and causes pressure to rise in the isolated brake cylinders of the second bogie to the same amount.

By returning the handle of the driver's valve (1) to the release position the control and direct brake pipes are emptied and the two relay valves allow the compressed air from the brake cylinders to escape to the atmosphere. The brake is applied and released progressively in the same way as a direct brake.

The automatic brake works as follows: If one of the units is used as a motive unit with trailers fitted with automatic brake, the automatic brake is used. In the feed position the whole of the installation is filled with air as already described, and is maintained at the same pressure by the feed valve (32) despite any possible leakage. If the driver wishes to apply the brake, he moves the brake handle to the service braking position and thus opens a small section of the automatic brake pipe and consequently causes the pressure in this pipe to fall. This drop in pressure is also produced in the branch to the control valve (7) where it acts on the control plunger which moves from the release to the applied position and thus connects the auxiliary receiver, through union 5, with union 3 and the control reservoir. At the same time, air flows by the union 16 to the relay valve F 1864 (54) where it acts in the manner described above; this valve passes air from the main receiver into the brake cylinder and through the control pipe to the relay valve B_3 (9) which, in turn, feeds the brake cylinders of the carrying bogie.

The brake force corresponds to the amount of pressure reduction in the automatic brake pipe. If the pressure in this pipe falls to 1.5 kg/cm^2 (21.33 lbs per sq. in.) the basic brake effort is exerted, that is to say, the pressure in the auxiliary reservoir becomes equal to that ruling in the control receiver and operating chamber of the relay valve F 1864 (54).

The automatic brake is also adjustable

in stages from full application to release; in the first case, by gradually reducing the pressure in the automatic brake pipe and in the second case by increasing it. When the pressure in the automatic brake pipe is restored to 5 kg/cm² (71.11 lbs per sq. in.), the brake is fully released.

The dead man's device is also operative with the automatic brake; its application will be described later.

If the driver has to make an emergency brake application, he puts the valve handle in the emergency application position and thus puts the automatic brake pipe in communication with the atmosphere through a large aperture. This results in a complete, sharp and sudden release of pressure in this pipe. By this the control plunger in the emergency brake valve (7) moves to the braking position. Through unions 2 and 16 it connects the emergency brake air receiver to the control plunger of the relay valve (54). The increase of pressure in this chamber causes increased pressure in the cylinders. As the pressure in the cylinder pipes is also effective in the control chamber of the relay valve B_3 (9) the carrying bogie is simultaneously braked to the same degree.

The displacement of the emergency brake piston also charges the connection (15) to the control valve (7) which causes the setting of the relay valve (51) to be changed, breaks the connection with the main air receiver and the compressed air from the receiver (52) can enter the feed to the compressed air circuit breaker (70). The circuit breaker closes and connects the corresponding sanding valves so that the sanding valves (23) at the front receive compressed air and sand is blown on to the rails. During this operation the tube (53) releases a little air. The tube is arranged so that the discharge of sand continues only until the set is stopped. At this moment the receiver (52) is exhausted by the tube (53) and the compressed air circuit breaker disconnects the sanding valves and causes them to close.

We have stated above that the relay valve F 1864 (54) feeds the brake cylinders of the driving bogie and the control pipe of the relay valve B_3 (9), allowing that in this case pressure introduced either directly or automatically by the driver's brake valve was transferred with a 1 : 1 ratio from the control chamber (union 16) of the brake cylinder pipe (union 30). This is, however, true only if the speed of the railcar set is above 96 km/h (59 m.p.h.). In the relay valve are four membranes which make up four control chambers. These membranes are of differing sections; according to whether the pressure from union 16 enters the small membrane chamber or the larger one, a smaller or greater pressure is obtained in the brake cylinder. In running at high speeds electro-magnetically controlled valves pass compressed air into the large chamber so that the large membrane causes pressure to increase in the brake cylinders in the ratio of 1 : 1 with the pressure received. If, on the other hand, the next smaller membrane is subject to the pressure, that which operates in the cylinders is raised to 80 % of the control pressure. This is the condition when speed is between 64 and 96 km/h (39 and 59 m.p.h.). The distribution of pressure in the following chamber causes the pres-

sure in the brake cylinder to rise to 60 % of the control pressure and distribution in the chamber with the smallest membrane to 40 %. These correspond to speeds of 32 to 64 and up to 32 km/h (19 m.p.h.) respectively. This means that at high speeds the vehicle braking is considerable and is reduced in three stages as the speed decreases until there is only 40 % pressure in the brake cylinders.

Three electro-magnetically controlled valves in the relay valve select the membrane to be used for transmission of compressed air to the cylinders. These electro-magnets are in turn controlled by a generator (55) driven from the axle, producing current in proportion to the speed of rotation of the axle.

Each car also has a relay cabinet containing three relays operated in accordance with the speed, connected or disconnected according to the tension provided by the generator. As the braking is automatically adjusted in four steps according to the speed, it is possible to obtain a high degree of braking for a reduced stopping distance.

Adjustment of the brake rigging : All the wheel centres are calculated to allow 20 mm ($^{13}/_{16}''$) tread wear. The distance from wheel tread (new) to brake shoe (released) is 7.5 mm ($^{19}/_{32}''$). When the distance grows to 20 mm, it is necessary to adjust the rigging by resetting the pivots on the brake triangle and the brake rod concerned for each axle.

The compressed air signalling equipment comprises a continuous communication pipe which is fed from the main receivers through reducing valves (62). To this pipe are connected :

1) a setting valve (66) by which a pull on a handle expels air from the communication pipe and causes a brief drop in pressure;

2) a C type whistle valve (64).

A drop in pressure in the communication pipe re-acts on the valve in the sense that a quantity of air escapes from its receiver to the atmosphere by the whistle.

By repeated drops in pressure, through valve (66), fixed signals, previously arranged, can be given to the driver on the set.

If the set fails to such an extent that it cannot be worked alone, it can be hauled by a locomotive with normal automatic brake. In this case the valve (67) must be open so that compressed air can enter the main receiver pipes and into the main receivers through the automatic brake pipe. Generally, valve (87) should then be closed to fill only receiver (26), the capacity of which is sufficient to feed the complete brake and communication system. When running as a defective set the double isolating valve (46) must be put in position II when the driver's brake valve is isolated from the automatic brake pipe and the control pipe.

The hand brake is a locking brake which can be operated from the driver's compartment on the driving bogie of each car. The operation of the hand wheel through bevel gears causes the rotation of the cardan shaft located in the front part of the frame and drives through a second cardan shaft a pair of

bevel gears mounted on the driving bogie, these gears in turn drive a screwed rod located vertically in the bogie and from this a brake screw. The rigging is connected to a cardan shaft acting on the screwed brake rod.

To adjust the tension in the chain of cardan shafts turn buckles are provided at each end of the pull rods.

Electro-magnetic rail brake : This equipment is used, along with the compressed air brake, only for rapid and urgent brake application, to obtain the shortest possible stopping distance. Whilst the adhesion between wheel and rail can be almost entirely used by the compressed air brake, the rail brake provides a new increase in brake force, since its friction is independent of the coefficient of adhesion between wheel and rail.

The electro-magnets of the rail brake are arranged between the two axles of each carrying bogie. They are hung from each side of the vehicle by two lifting cylinders. To control the cylinders each carrying bogie has an electro-valve for operation and release. Compressed air is taken from the main receivers through a flexible pipe and isolating valve.

In the coach is a brake contactor which when energised feeds the windings of the brake electro-magnets with current from the battery. An indicator light on the control panel lights up when current is flowing. The control current for exciting the contactors and electro-valves is also taken from the main battery. The driver's valve comprises a winch release contactor which automatically closes the control circuit when the driver's handle is placed in the rapid braking position and re-opens automatically when the handle leaves this position. As a result of the operation of this pressure switch, the automatic operation of the magnetic rail brake is possible only when there is suitable pressure in the main air receiver and because of the switch it can only be applied above a specified minimum speed.

When running, the electro-magnets of the rail brake are fixed 55 mm ($2\,^3/_{16}''$) above rail level; the length of stroke of the lifting cylinders is 130 mm ($5\,^1/_8''$). To indicate to the driver that all the brake electro-magnets are in the raised position and the brake released, indicator lights are provided in the cab. To switch in the magnetic rail brake for rapid braking it is only necessary to move the handle of the driver's valve to the rapid braking position. The magnetic rail brake is operative so long as the handle remains in this position. It is disconnected and the brake magnets raised as soon as the handle is moved from the rapid braking position. For an emergency brake application, the action of the driver is limited to a movement of the brake valve handle to the rapid braking position, thus applying the increased brake force through the operation of the emergency brake valve.

VII. Water supply and air pressure equipment.

The luggage compartment car has the following water tanks;

two 300 l (66 gall.) tanks for drinking and non-drinking water;

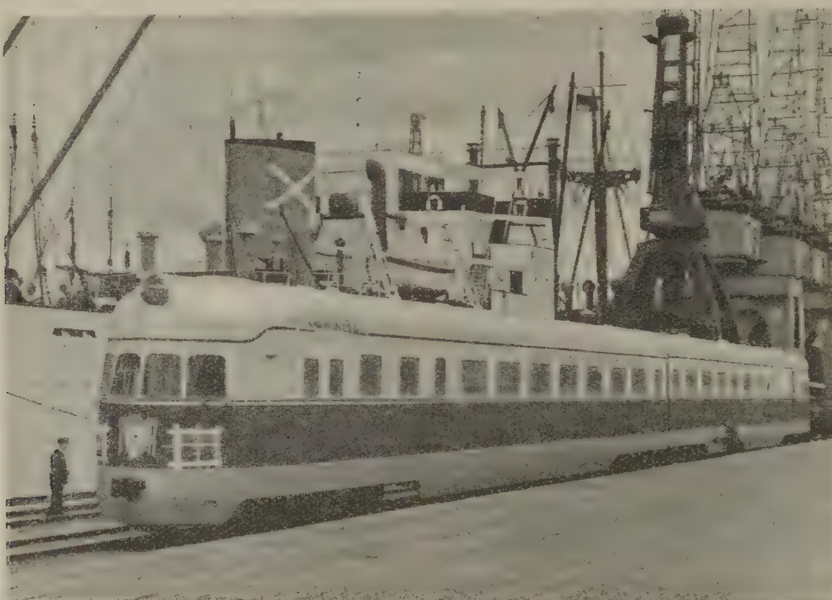
one 650 l (143 gall.) tank for the air conditioning equipment.

The kitchen car has :

three 300 l tanks for drinking and non-drinking water;

one 650 l tank for the air conditioning equipment.

These tanks are fixed to the frame separately. They have side filling unions and after setting a valve, can be filled from either side of the car, as desired, by means of a compressed air filler pipe. Compressed air is also used for passing water from the tanks to the using points. The water system includes a regulating valve which admits compressed air to the water system only when the pressure is 4.5 kg/cm² (64 lbs per sq. in.) or above whilst a reducing valve limits pressure in the system's air receiver to 1.4 kg/cm² (19.9 lbs per sq. in.).



Twin railcar before shipment.

VIII. Various.

At the request of the Mexican Railways, each driving bogie has been fitted with a De Lymon flange and rail lubricator. This lubricates only the guiding flanges of the car. The checks of the greased rails transfer the lubricant to the other tyres which are less highly stressed. Grease lubrication is used, pumped and blown by compressed air, in jet form on to the bearing surface of the flanges. Operation is short and automatically repeated during running at regular fixed intervals.

Each railcar has a powerful electric

bell which is rung when approaching stations, from the driving compartment and, there is also a warning signal of four harmonised horns which is audible over a distance of 12 km (7 miles). A valve, which is operated by the driver, supplies air to the warning horns. All the warning equipment is located behind a metal grill in the lower casing of the front ends.

External painting, marks and lettering; apart from the rear wall (short coupled), all the external walls have been painted «Bordeaux» red up to the waist rail. The remainder of the walls are painted in a shade of beige whilst the roof and skirting are painted aluminium. The mouldings along the outer walls are painted a deeper shade and the whole aspect of the twin set is particularly good. On the front ends the escutcheon of the Mexican Railways is boldly displayed.

Trials have been carried out on widely varying lines of the German Federal Railways to verify speed, braking and running qualities in the presence of a Mexican Railway Engineer. The various units of these sets have covered an average of 2 000 km (1 250 miles), and have shown excellently stable running.

Special precautions were taken before shipment. The cardan shafts were removed well greased and crated; the Diesel Motors and transmissions also being dealt with under specified conditions.

The railcars were conveyed by a Dutch boat to an American port whence they were hauled by freight train to a Mexican station. They were restored to complete readiness only when they reached the lines on which they were to work. A representative of Linke-Hoffmann-Busch in Mexico was at the service of the Mexican Railways to give advice on putting the cars into service.

Similarly, « Maybach Motorenbau » and Brown-Boveri (Railways Dept) were represented to assist in the inauguration. The selection of driving crews has commenced.

The twin cars' already delivered, which have been exhibited in Mexico, have been inspected by high Mexican personages and have been very favourably received.

[653 .23 (73)]

What differentials in rates ? (*)

Some of the old ones, based on market relationships, will have to go—but some are needed in today's competitive situation.

By W. G. Scott, (**)

Transportation Economist, Railway Association of Canada.

(From *The Railway Age*, October 17, 1955.)

The question of traditional differentials in railway rates will be considered in this essay from the standpoint of the needs of the railways in a highly competitive transportation market. Not only traditional differentials in railway rates which have evolved under monopoly conditions will be taken into account, but also the new considerations which might reasonably be expected to influence railway rate differentials under existing competitive conditions.

This paper is developed against a background of Canadian conditions, which are most familiar to the writer — but reference, where appropriate, is made to conditions in the United States and Britain.

The economist thinks of traditional differentials in railway rates in terms of differences in demand for and costs of railway service; whereas the practical traffic officer thinks more in terms of differences in the: (1) value of the commodity; (2) mileage; (3) size of shipment; (4) competition; (5) speed or relative service; and (6) type of railway equipment needed.

DIFFERENCES BASED ON VALUE.

The freight classification, or grouping of commodities into a limited number of classes on the basis of their value, is the classical example of traditional rate differentials. It was designed to extend market opportunities as widely as possible in the interests of encouraging both a uniform development of a country and a maximum development of railway traffic. The rates for each class of traffic were to bear a proper relationship to the rates of all other classes; and the revenues from all rates taken together were to be related to the railways' total costs. *The freight classification has represented a complex system of bonuses and taxes, taxes being levied on some commodities far above the full cost of service and bonuses given to other types of traffic which have been traditionally carried below cost.*

Satisfactory as the railway rate structure was under monopoly conditions, it nonetheless was artificial, and was far removed from the normal concept of prices in a highly competitive economy. Its artifi-

(*) Second prize paper in Monon-Railway Age contest.

(**) Since this essay contest closed, Mr. Scott has been appointed general secretary of the Railway Association of Canada. The views set forth in this paper are his alone. For publication in *Railway Age* this essay is slightly abridged. It is planned to reprint as a pamphlet available from *Railway Age* the two prize-winning essays (the first of which was published in the September 19 issue, page 46), and several other papers selected by the judges as of outstanding value. Single copies of this pamphlet will be priced at $ 1, with reduced prices for larger quantities.

ciality, moreover, became a matter of practical importance to the railways with the development of a number of competitive carriers.

What then is the practical significance to the railways of traditional rate differentials based on the value of commodities? Simply this — large blocks of high rated traffic have been, and are continuing to be, diverted from the railroads to common, contract and private carriers, not because these carriers can handle high valued commodities more economically than the railways, but rather because such traffic can be moved more cheaply than at the prevailing railway rates which are not based on the cost of individual shipments. Of even greater importance is the fact that the large profits made by motor carriers from many of these rates have enabled them to profitably back-haul certain traffic which under normal circumstances would be outside their economic sphere of operations on the basis of their true costs.

Under existing competitive conditions, the overemphasis of « values » in the freight classification has functioned as a double-edged weapon against the railways, resulting not only in the loss of large amounts of high-rated traffic on which the railways have traditionally relied for a major proportion of their overhead costs, but also in the loss of a growing volume of low-rated traffic which is being moved as fill-up traffic in the backhaul. The real anomaly is that many of the high railway rates are nothing more than « paper » rates, as the traffic has long since been lost to the railroads. On the continuation of these « paper » rates, however, rests the strength of the railways' competitors.

Effect of contract carriers.

An equally important consequence of the over-reliance on the value principle in rate-making has been the progressive growth of contract and private carriers. Contract carriers by being able to secure traffic on a guaranteed basis (see the case of *New Automobiles in Interstate Commerce,* 259 ICC 475) base their rates on actual costs rather than on railway rates, as do common motor carriers, and so cut into rail traffic. Then too, many large shippers of high-grade commodities, dissatisfied with common motor carrier rates, based on railway rates, have turned in increasing numbers to private carriage. As an indication of the importance of this form of carriage, 43.4 % of all Canadian intercity truck traffic in 1953 was moved by private carriers alone. Efforts on the part of some regulatory boards to maintain the traditional rate differentials based on value, in the interests of preserving rate relationships between different types of commodities, cannot help but be ineffective under these circumstances.

A gradual reshaping of the freight classification will probably entail some redistribution of transportation costs between different types of commodities, but this must be accepted as an inevitable consequence of the continued growth of competition. The railways would seem to have no alternative.

This is not to suggest that value will not continue to play an important role in rate making, but rather that the upper limit for many types of traffic will be influenced in the future by the costs of private and contract carriers.

Dr. E. G. Plowman, vice-president traffic, United States Steel Company, in his Salzburg Memorial Lecture on Transportation, at Syracuse University, February 14, 1955, stated the nature of the problem in this way:

« Private truck transportation cost is becoming a competition-type upper limit of the common carrier freight rate zone of reasonableness that may gradually supplant the upper limit established by laws and regulatory decision. »

Two of the most important examples of traditional railway rate differentials based on value have been the wide divergence in rates between raw materials and

finished goods; and between export-import traffic and domestic traffic.

Railways cannot hope to continue to maintain the extreme differential between rates on raw material and finished goods if the manufacturers of the finished products are to turn in increasing numbers to contract and private carriage. Nor have they the ability to maintain the extremely low rates on export-import traffic in competition with water and motor carriers for higher rated domestic traffic. Canadian railways have long been faced with this problem in its most extreme form.

MILEAGE-BASED DIFFERENCES.

Differentiation of rates on the distance principle has been simply another manifestation of the need for extending markets as widely as possible. The theory that tapering of rates is justified by the spreading of terminal costs over increased mileage is indeed true, but it falls far short of a full explanation of the pronounced taper which has long existed.

What then is the practical significance of the traditional railway rate differential based on distance? *A pronounced taper of railway rates results in relatively low rates where the railways' competitive position is strongest, and high rates where their competitive strength is weakest, or just the reverse of what competition demands.* Motor carrier costs, because of the small overhead component, progress in a relatively straight line as compared with rail costs. It follows that their most effective sphere of operation is in the short distance field and least effective for long hauls. But the rail differential, based on mileage, is least pronounced for short distances, and most pronounced over long distances.

The traditional type of mileage differential under existing competitive conditions, therefore, is becoming a competitive advantage for contract and private motor carriers in short hauls, and may be unnecessarily depleting rail revenues for long haul traffic where the railways' competitive advantage is greatest. It is appreciated that the pronounced taper has been designed to develop long-haul traffic by extending marketing over wide distances. But from the standpoint of competitive strength, it is of the utmost importance that long-haul rates be no lower and short-haul rates no higher than absolutely necessary.

This principle was directly involved in the Interstate Commerce Commission's decision on new automobiles (279 ICC 377). A group of U.S. railways were prohibited from reducing their short-haul rates, to meet effective motor carrier competition, unless equivalent reductions were made on long-haul traffic, where competitive conditions were not the same. It is interesting to compare the decision of Canada's regulatory authority in an identical case on refined petroleum products (Board of Transport Commissioners, Order No. 79133, page 124). The railways' case for reduced rates on short-haul traffic, if competition is to have any meaning, is whether the proposed rates are remunerative *per se* rather than their relationship to the long-haul rates.

SOME RATE DIFFERENCES THAT ARE QUESTIONABLE.

- *Those based solely on « value » of the commodity, especially those which take account of « value » of competing commodities — or which underrate raw materials while overrating finished products.*
- *Those based on too sharp a « taper » of long-haul rates — resulting in high rates where competition exists and in low rates where it doesn't.*
- *Those which fail to take into account that it doesn't cost much more to haul a 30-ton carload than a 15-ton carload.*
- *Those which try to preserve « market relationships » — where unregulated transportation has already broken these relationships.*
- *Those which fail to allow a slower carrier to charge less than a fast one.*

DIFFERENCES BASED ON SIZE.

Because the costs associated with carload and less-than-carload traffic are very different there has long existed a justifiable rate differential.

The important question, however, is whether the application of the principle as applied to carload minima might not be further extended to permit the railways more effectively to meet the growth of competition from contract and private carriage. The average railway car's capacity is 80 000 to 100 000 lb, yet a surprising number of carload minima range from 24 000 to 40 000 lb.

Where rail and truck rates are comparable and the rail carload and truckload minimum weights are the same, the shippers' choice of carrier is limited solely to differences in relative service. But one of the railways' basic inherent advantages is size; and probably nowhere in the transportation industry is the law of decreasing costs brought home more forcefully than in the case of railway car loading. The following example for a 350-mile haul illustrates the decreasing nature of rail costs as car loading increases :

Minimum weight (lb).	Index based on actual rail costs; 20 000 lb = 100.
20 000	100
40 000	59
60 000	41
80 000	32
100 000	29

WHERE NEW RATE DIFFERENCES ARE NEEDED.

- *Those which would compensate a shipper for the reduction in cost which derives from dependability of his patronage — and which would penalize the shipper who uses the railway only as a « stand-by ».*
- *Those which would permit lower charges on heavy-traffic, low-cost routes than are levied for equal tonnage and distance on lines which are costly to operate. The more railroads are forced to « average their costs » in their rates, the more opportunities they leave open for pick-and-choose competitors.*

The railways cannot afford to allow the size of shipments to become a matter of indifference to shippers in their choice of competitive carriers.

Because the railways' unit of transportation is the train, not the car, it has even been suggested that differential rate-making based on size of shipment should not stop at carload quantities. Certainly if, through the use of multiple-car and train-load rates, railways could improve their net revenue, they should have the freedom to introduce such rates. In the case of volume traffic moved by contract and private water transportation, the railways might well make use of the principle to good advantage. It is doubtful, however, whether it would improve the railways competitive position vis-a-vis contract and private motor transport, and it might even sacrifice net revenue in some cases. This should be a matter for managerial discretion, the decision being dependent upon individual circumstances.

DIFFERENCES FROM COMPETITION.

Differences in competitive conditions have long been recognized as justification for differential rates between shippers of the same commodity. Canada's Railway Act, for example, specifically provides for this; and the Canadian Royal Commission on Transportation, 1951, in its conclusions on competitive rates stated :

« The railways should neither be denied the right to meet competition, nor when once they have decided to publish competitive tolls... to be forced by law to apply these same tolls... where competition between transportation agencies is non-existent. »

The Interstate Commerce Act seems to be less precise on this question that its Canadian counterpart, but from what Professor I. L. Sharfman says in his work on the Interstate Commerce Commission, the regulatory laws of the two countries seem to be much the same on this point. At p. 323 of Volume III, for example, he states :

« ... traffic considerations may legitimately be permitted to exert a large influence in the adjustment of rate relationships. »

He then lists a number of these considerations, prominent among which are « differences of competitive condition at different points »; and the commission is authorized by the act to permit the railway to charge less for longer than for shorter distances « under certain circumstances », one of which is actual competition.

The application of the law in the United States and the law itself, however, would appear to have parted company. An excellent practical illustration of this was cited in the February 28, 1955, editorial in *Railway Age*. The Burlington in an attempt to retain certain traffic — steel products — between Sterling, Ill., and the Twin Cities, in competition with a contract motor carrier, wished to reduce its rates. Regulatory orders, however, prohibited this type of specific rate action unless similar reductions were given to all other points within a fairly wide area which were served by the common supply point, Sterling. Rates for the same commodity from a number of other supply points to the common market, Twin Cities, would also have had to be reduced. The railroad had no alternative but to withhold the rate reduction, and so forgo the competitive traffic, in order to protect its revenues on traffic not subject to competition.

Who gained by this regulatory decision? One party alone — the contract motor carrier which retained the traffic. The Burlington lost revenue which it might otherwise have earned, and those shippers who had no alternative transportation facilities still had to market their goods in competition with a supplier who enjoyed a transportation cost advantage. Regulation under these circumstances fails in two respects. It is unable to guarantee equal transportation costs for all shippers; and it seriously affects the competitive strength of common carriers.

If a railway by offering one shipper a reduced rate finds itself compelled to offer the same concession to all shippers of like commodities, where competition does not exist, then the railway is faced with this economic dilemma. Either it must lose the first shipper's traffic to its competitors, or the traffic of all other shippers must be carried at equally favorable rates. If the railway accepts the first alternative it loses the potential revenue from the traffic of the shipper who has at his disposal alternative forms of transportation facilities. Accepting the second, it dissipates its revenues from the traffic of those shippers not favored with competitive facilities.

A large volume of traffic is affected by this provision of the law. For example, all commodities of the same kind which are produced in different localities and consumed in the same place or exported through the same port are regarded as the same or similar traffic.

The commission would also appear to be reluctant to give relief from the effects of competition in the case of long and short haul discrimination. The railways, therefore, lose valuable revenue at competitive points for fear of dissipating their revenues at intermediate points. The intermediate points do not benefit, because the more distant non-competitive points simply obtain the reduced transportation costs from the railways' competitors. The intermediate points over the long pull are actually injured, because their rates are higher than they would otherwise be if the railways were allowed to share in the revenues available at the competitive points.

If railways are to effectively meet the growing competition of contract and private carriers, they must be permitted to price their services differentially, to give effect to differences in competition at different points. Prohibition against this form of differential rate-making fails to benefit the shippers it is intended to protect, because the railways are compelled to forgo the competitive traffic rather than dissipate their revenues on

non-competitive traffic. Furthermore, the favored shippers gain a competitive transportation cost advantage by being able to turn to contract or private carriage. This type of restraint has contributed materially to the growth of contract and private carriers.

When are differentials iniquitous ?

The most important obstacle in the path of the railways' adopting a new approach to differential rate making is the concept of discrimination. *Regulation should only be interested in controlling that form of discrimination over which the railways have some effective control, such as secret rebates and concessions not justified by differences in costs or demand.* Discrimination in rates to meet competition, differential charging based on demand, should be permitted without requiring the railways to extend the competitive rate to all other traffic of a similar type, for which there is no compelling competition. Similarly, differential charging based on established difference in costs must not be allowed to become a convenient tool for the forced reduction of other rates where the same cost considerations are not applicable.

If railways are to effectively meet competition, moreover, they should be permitted to price their services differentially to meet *potential* competition. Refusal to permit the railways to do so encourages competitive forms of transportation to purchase equipment and facilities on the basis of existing rates. When competition becomes effective, however, the railways then can reduce their rates to meet it. The competitive forms of transportation, having made their investment, meet the new rail rates and a rate war has been unnecessarily precipitated. Permitting railways to meet potential competition by means of rate adjustments would do much to prevent this situation arising. Alternatively, if the shippers have set up their own private transportation facilities it is almost impossible for the railways to regain traffic lost to private carriers.

Differences in seasonal competition has also been a traditional basis, in Canada at least, for rate differentiation.

Summer and winter rates are a valuable part of the rate structure, and are simply a recognition of the test of practical rate-making, or the recovery of variable costs on the cost-service principle, and overhead costs on value of service. This principle should be retained, because the railways cannot be expected to provide stand-by capacity during certain seasons of the year when competition is ineffective without being permitted to recover their full costs of operation for year-round service.

DIFFERENCES IN TIME OR SERVICE.

Differences in types of services have long given rise to rate differentials, as evidenced by the difference in freight and express rates. As competition grows in intensity the need for reflecting differences in the service will become increasingly important.

Regulatory boards have, in fact, recognized this requirement by permitting a lower rate for water than for rail transportation because of the superiority of rail service. If competition between railways and motor carriers is to be equally effective, it would seem only logical to extend the principle to them as well. But there seems to be a reluctance to do so.

The question might well be asked how is it possible for competition to function effectively when rates are equal and service different ? Under these circumstances price, one of the most important considerations of competitive enterprise, is removed as an automatic guide to relative competitive advantages of different carriers. The cards cannot help but be stacked against the carrier with the inferior service regardless of its costs relative to those of its competitors.

Time, or the service factor, should, therefore, be reflected in the rates of competing carriers if competition is to be meaningful. It is possible through regulation, where competition is between like carriers such as between railways whose cost and service characteristics are similar, to relegate rates to a secondary role. It is not possible to do so, however, where competition is between carriers of entirely different cost and service characteristics, such as motor carriers and railroads.

Differential rates to reflect differences in the cost of various type of equipment are completely sound and should be retained as part of the rate structure. Due to space limitations and the obvious justification of this type of differential it will not be examined in detail here.

NEW REASONS FOR RATE DIFFERENCES.

With the possible exception of rate differentials for differences in types of equipment, the predominant influence in traditional railway rate differentials has been value of service or demand considerations. Understandable as this was under monopoly conditions, competitive reality now requires that cost considerations be given at least an importance equal to that of value. This should come as no surprise to those who understand the workings of our free enterprise system. Bankruptcy courts are littered with the « carnage » of those who have failed to take heed of the basic importance of costs in competitive pricing.

Regularity deserves a discount.

For reasons of space, consideration of this question will be confined to the two most important examples of this requirement. These are : (1) rate differentials based on regularity; and (2) rate differentials based on differences in route costs.

Regular patronage is a boon of no little importance to a business. Sharp fluctuations in demand may be likened to a dagger pointed at the financial heart of a competitive business. For industries with heavy capital investment, sustained patronage is a prerequisite to the lowest possible costs of operation. Regularity produces significant cost reductions, whereas sporadic patronage has exactly the opposite effect. It is not surprising, therefore, that considerable time and money are spent, and varied techniques employed, in radio advertising to encourage « repeat orders »; or that public utilities employ a two-part tariff to recover their overhead costs regardless of the use made of their service.

Regularity, by reducing the element of risk, is of fundamental importance to railways, an industry of decreasing costs. Through advance knowledge of the demand for their services, the regular shipper permits the railways to minimize their costs of operation. It is only common business sense, therefore, for railways to recognize this important consideration in their rates. The sporadic customer who encourages the railways to invest in plant and equipment, and then uses them as stand-by facilities, is an expensive luxury. It is true that through the use of commodity rates, the railways have recognized the importance of regularity — but these have not been sufficiently effective, judging from the growth of contract and private carriage.

Canadian and British Railways have been authorized to establish their own contract rates, « agreed charges », as an incentive to regular patronage. Through this form of charging they have been able to regain lost traffic, and more effectively retain what they now have.

Regularity of patronage results in lower operating costs for railways and should justifiably be reflected in railway rates for competitive reasons, at the discretion of railway management. Prohibition against doing so on the grounds of pre-

serving rate relationships between competing shippers, moreover, is meaningless where shippers are able to turn to contrat and private carriage.

Differences in route costs.

Railways have not been permitted to differentially price their traffic to reflect differences in costs along different routes. A given class of freight must be carried between all places equidistant at very much the same rate. Yet in no aspect of rail operations do costs very so markedly as along different routes.

The problem may be illustrated by an extreme case. A large and regular flow of traffic moving between two large centers of commerce clearly costs less to carry per unit of traffic than irregular and light traffic moving between two rural points situated the same distance apart. The large regular flow of traffic produces good utilization of equipment, and normally a balanced directional traffic flow; the light irregular traffic route is associated with just the opposite characteristics, an expensive operation. A recent cost study published by the British Transport Commission, for example, revealed that for certain types of traffic, costs on light traffic routes were as much as 40 times the cost on main lines, yet the rates were equal.

What, then, is the practical significance of the traditional prohibition against rate differentials for different routes where costs differ?

As common carriers *the railways have been forced to average their costs over remunerative and unremunerative routes, resulting in rates above actual costs along heavy density routes.* Contract carriers, and large shippers with the resources to operate private transportation — recognizing the artificiality of rates along these routes, and free from any requirement to provide service which is unremunerative — have tended to concentrate their operations between large centers along heavy density routes, where capacity loads are available as well as fill-up traffic when required. The same is also true for the railways' so-called common carrier competitors. The result has been a distortion of competition.

To rectify the situation, railways should be permitted to establish differential rates to reflect differences in costs between routes.

Failure to permit them to do so will simply further encourage the growth of contract and private carriers, and undermine the competitive strength of railways, the only true common carrier. Attempts to preserve the rate relationships between shippers on main lines and off-line points cannot be effectively maintained in any case, because of the ability of volume shippers located along heavy-traffic arteries to circumvent regulatory objectives by the use of contract carriers or by the establishment of their own private transportation.

COST AND VALUE, BOTH IMPORTANT.

There are those who contend that cost considerations alone should determine the role of rate differentials in a competitive transportation industry, and there are those who hold just the opposite view that value-of-service or market considerations, long the most important influence in traditional railway rate differentials, should be even further extended if the railways are to effectively compete in today's transportation market. It is the contention of this writer that the answer still lies in the intelligent use of both principles but with a change in the emphasis of each.

Low costs are consistent with regularity and volume which are found primarily along main traffic routes over which the railways have long ceased to monopolize traffic. Economic realism, therefore, requires the railways to reflect in their

rates, to a greater degree than they have been permitted to do in the past, the effects of regularity, heavy loading and sustained patronage. From the standpoint of competition, the railways' strength lies in long-haul traffic which they should be careful not to dissipate by unnecessarily low rates; and conversely their weakness is to be found in the short-haul field where the pronounced effect of the tapering principle tends to intensify their competitive problem.

Value of service still has an important contribution to make in competitive rate-making, but greater stress will have to be laid on « service » relative to that of other carriers, and less on the « value » of the commodity *per se*. *The costs of other carriers must be the determinant of the upper limit of rail rates rather than the value of the commodity.* The competitive requirements of carriers, moreover, rather than the maintenance of rate relationships which cannot be effective with the growth of unregulated carriage, should be recognized. Arbitrary extension of the benefits of competition to points where it does not in fact exist can have only one result — depletion of potential rail revenues and the continued growth of contract and private transportation.

[656 .23 (73)]

Traditional differentials... in rate making.(*)

The traditional differentials of the past can and should be maintained only to the extent that all of the resultant rates meet the twin tests of covering the cost of service while not exceeding the ceiling set by competition.

By Alan M. WHITE,

Member, Railroads' Tariff Research Group.

(*Extract from the Railway Age*, September 19, 1955.)

We publish hereafter the most interesting part of another article, on the same subject than the preceding paper, written by Mr. Alan M. White. This paper has, in fact, been awarded the first prize of the « Monon-Railway Age » contest, organized at the suggestion of Mr. Warren Brown, President of the « Monon Railroad Cy. ».

The author recalls first of all that the « skimming » of the traffic by the road services has dislocated the general structure of the tariffs existing previously, and this was done more or less accidentally by local competition, with the result that finally different tariffs overlap and the whole structure of the rates is somewhat mixed. At the beginning of the competition, the American Railroads, as their profits were sufficient, remained unconcerned. Afterwards, a certain amount of competition started between road carriers, whereas the manufacturers were organizing their own road transport. The railroad lost a great deal concerning its part in the total general traffic, but also on the absolute volume of traffic. The author continues :

. . . . . .

Elements of competitive pricing.

For generations the railroad rate makers, in the face of all the limitations on their freedom, had been forced to act on the practical premise that there was just so much traffic to move and it was up to them to get the most revenue from it. This precept is still as good as ever when applied to the many commodities that by their nature are ill-suited to motor carrier movement, but it is woefully inappropriate where a competitive element is present.

In the short run the free market price may be above or below the cost of production but in the long run it will approximate the cost plus a reasonable profit of the most efficient producer. The important point is that from the standpoint of the seller the price is fixed for him without his control. His only election in the matter is whether he will or will not do business at the price. That is the Hobson's choice that faces the railroads on the very important part of their traffic that is subject to the competition of other forms of transport.

In the short run it is the price of their competitor the railroads must meet, in the long run his cost of operation. These factors will determine the relation-

(*) First prize winner in Railway Age essay contest.

ships that can be maintained between places and commodities and industry will have to adapt to them as it has had to other changes in the economic scene.

As indicated, a competitive price is a fluctuating price. Much as the public may desire stability in rates, relaxation of the past rigidity will have to be accepted as a sacrifice in return for the lower rates that competition has brought to a large segment of the rate structure.

A competitive price does not in the long run return a profit that can be used to sustain losses elsewhere. To the extent the railroads engage in competitive pricing they will have to think carefully before extending sympathetic adjustments to other movements where the results would be lower rates than dictated by the competitive situation pertaining to those movements.

The first fundamental of a realistic rate-making policy is to develop an adequate method of computing and allocating cost. This will be difficult, but it should not prove insurmountable. There are very few one-product business enterprises in the country and any company with a multiplicity of products has the same problem of apportioning overhead and other joint costs. The commission has for several years released statements of fully distributed and out-of-pocket rail costs for various types of equipment and loading and many roads have been at work on the problem.

The importance of a good cost system cannot be overestimated.

With the railroads' most profitable traffic lost or handled at drastically reduced rates something had to give. To date it has been the earnings. Too much of the transportation business is subject to competitive forces to apply the old family remedy of a general increase in rates. Undoubtedly such measures are required to offset currency inflation but the commission's concern in granting the most recent ex parte increases that they would drive traffic off the rails has not proved entirely groundless.

In processing any rate adjustment the traffic man should be armed with his out-of-pocket costs and under no circumstances should a rate be permitted to stand that does not return this figure plus. It is fallacious to think that volume has any magic to offset unit losses.

As to any particular commodity these absolute minimum figures can be projected as a mileage scale in terms of cents per unit of weight. Against these should be set a similar scale of fully distributed costs, and efforts should be made to hold the latter as the minimum for any non-competitive traffic. Where truck competition is present, there should be added a third scale to represent the truck rates and a fourth scale to show truck costs. The latter two will indicate the maximum that can be charged for the short run and long run, respectively.

Where truck costs are below rail costs at the heaviest loading practicable, the railroads should stay out of the business. Where the truck rates and costs are between the rail out-of-pocket and fully distributed costs the rails should meet their competition as they find it. Where the truck costs are above rail fully distributed costs, the rate maker should exercise his judgment as to the measure of rate that will produce the most net — with due regard for the development of volume through establishment of relationships between producers.

Alternating rates with different minimum weights are effective means of securing traffic that cannot be handled profitably at the truckload minimum weight. A rule of thumb for applying this technique is to give the public the minimum weight it prefers but at a rate that covers cost at that weight, and then provide a lower rate, based upon heaviest practicable loading, that offers the public a lower unit cost while productive of greater net to the carrier, there being little difference in cost between the handling of a fully loaded car and a lightly loaded one.

In the past, once a rate adjustment

has been published in the tariffs the papers have been sent to file and the matter forgotten until or unless some trouble arises. No other business is conducted in this manner. Operators in competitive fields watch both the market prices and their costs on a daily or even hourly basis.

Great changes have taken place in the distribution of rail costs. Terminal costs have gone sky high as labor rates have risen, while dieselization and other improvements have held line-haul costs steady. Virtually nothing has been done to revise the rates on traffic formerly profitable but now deficit producing. The railroads should conduct a continuing review not only to keep themselves profitably competitive but to eliminate and correct developing losses.

The rate structure of the future.

As previously pointed out, differentials in the old rate structure were not scientifically devised. Industry adapted to them largely as it found them — and in the process, of course, acquired a certain degree of vested interest in their maintenance. Competition has disrupted these relationships to a considerable extent, but with few ill effects on the shipping public.

Fixed differentials are symbols of a static society and more important factors are constantly at work to determine the size, nature, location and marketing areas of private business. Modern business is highly adaptable to changes in its environment and does not need to rely upon crutches supplied by the railroads.

Many years ago the commission prescribed a relationship between the rates on livestock and those on fresh meat designed to equalize costs of meat packing in the Midwest with those of packers in the consuming area along the Eastern seaboard. This did not stop the meat packers from moving their slaughtering operations to the livestock producing areas when the economics of the situation made it desirable to do so and for the benefit of all concerned the profitable meat traffic was relieved of the burden of supporting an unprofitable livestock movement.

No one expects to ship sand and gravel from coast to coast, and it will likely come to pass that many other movements that have become an unbearable burden upon other traffic will have to undergo some adjustment.

Regional assembly plants are commonplace in industry. These are established not necessarily to eliminate cross-hauling but generally for the purpose of reducing the transportation of a bulky finished product to gain the economies of shipping the components in a more easily transportable form.

The traditional differentials of the past can and should be maintained only to the extent that all of the resultant rates meet the twin tests of covering the cost of service while not exceeding the ceiling set by competition. Like Sinbad the sailor, with the old man of the sea upon his back, the railroads are saddled with a burden of the past that is sapping their energies and from which they must eventually take the necessary steps to free themselves.

Since this analysis is an interpretation of the experience and observations of a single individual, the conclusions drawn may well reflect personal limitations in dealing with so extensive and complex a subject. It is hoped, however, that it has been established :

- That the rate policy of the past was not something ordained in heaven but a practical method of coping with the problems of the day;
- That changed conditions call for changed policies; and
- That intelligent analysis and careful planning are much to be preferred to a *laissez-faire* attitude of « muddling through » until evolution produces a new philosophy capable of surmounting the challenge of the future.

[656 .212 (73)]

N & W classifies cars automatically.

Perforated tape equipment directs routing of freight cars at N & W's Portsmouth coal yard.

(*Modern Railroads*, October, 1955).

The Norfolk & Western Railway brings automation of freight car classification a step nearer. Recently at Portsmouth, Ohio, it began using a new system for automatically routing cars to the proper classification tracks. Actuated by electrical impulses from a perforated tape machine, switches operate as the cars roll.

car's speed, bringing it down to a safe, predetermined rate. Ahead of the rolling car, switch points snap into position, directing the car into the proper classification track. No human hands have operated a switch or touched a routing button. Only the four group retarders are manually controlled.

Key to the automatic routing of cars at N & W's Portsmouth Yard is the teleprinter. When switching list is transmitted to the retarder tower, a tape showing car routings only is perforated.

Part of an $ 850 000 improvement program at Portsmouth, the new system, together with other changes, enables the N & W to classify cars faster and with less damage to equipment than ever before. Also the loss of coal has been minimized.

At Portsmouth, cars loaded with coal roll one by one down the hump. The master retarder automatically checks each

Though only one tower is required today, two retarder towers had been needed previously to handle master, group, and final retarders. By redesigning the yard, all final retarders were eliminated.

Outstanding feature of the new yard is the method by which automatic operation of the switches is achieved. In the

normal mechanized yard, electronic facilities provide for no more than four or five advance selections. The Union Switch & Signal system at Portsmouth will handle a train of any length. Known as the Teletype Tape Storage Feeding System, it permits the classification of an entire train without an operator pushing a single route button.

Secret of the new method lies in the perforated Teletype tape. It is this tape which controls the sequential operations. The Teletype tape is received simultaneously with the switching list at the retarder tower.

The sequence of events begins when a westbound coal train arrives at Portsmouth. The conductor takes his wheel report, which is in train order, to the yard office. There, the assistant yardmaster prepares a switching list from it, assigning the cars to various classification tracks.

Next, a yard clerk transmits the switch list to the car retarder tower by means of modified Teletype equipment. The Teletype transmitter has been arranged so that an electrical contact is made when its carriage reaches the space for the track number.

The closing of this electrical contact starts a perforating machine attached to the Teleprinter. This machine, located in the car retarder tower, punches a tape which lists the destination tracks for cars in train order. No other information is recorded.

When a particular cut of cars is ready for humping, the operator inserts the perforated tape associated with these cars into a modified Teletype transmitter-distributor adjacent to the control machine.

He then operates a control button marked, « Tape Start ». The transmitter-distributor (mechanical operator) feeds five « orders » into the storage banks of the Union Switch & Signal's automatic switching machine. The electrical impulses actuate storage relays which in turn control the conventional automatic switching apparatus. This operates the track switches required for the particular classification.

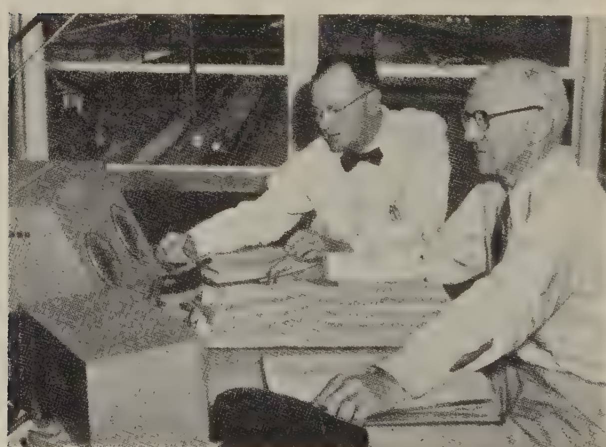
Transmitter-distributor feeds car routings progressively into decoding unit which instructs the automatic switching system.

As each car moves over the hump, the transmitter-distributor progressively feeds additional classification instructions into the switching apparatus. Thus, the operator is free to devote his time to the four group retarders which remain under manual control. This results in greatly increased control over the car's speed.

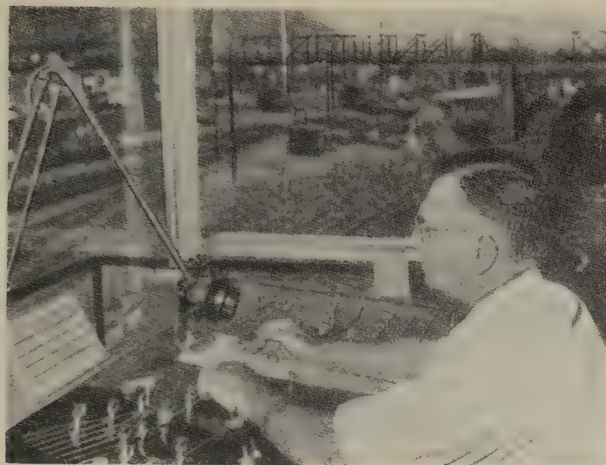
With the new system, all cars roll over the hump individually, and each car is weighed in motion as it passes over the scales. Few, if any, empty cars are handled.

« Blowouts », that is, cars which the

No human hands operate switches or routing buttons at N & W's Portsmouth classification yard. Automatic classification is but a part of an $ 850 000 improvement program in one of nation's first hump yards.



Operator in retarder tower checks car numbers against his switching list. Also he manually controls the four group retarders and can re-route cars or take control away from the automatic system any time.



Glass enclosed penthouse atop the scale office gives the assistant yardmaster a clear view of all operations. Two-way radio and loudspeaker communicating systems enable him to give instructions to all.

Heart of the automatic system lies in relay equipment room. Special circuits reject typing errors such as letters or single digit numbers.

weighmaster is unable to weigh accurately as they pass the scales, are diverted to a hold track. The retarder operator diverts them by depressing a push button marked « Blowout ». When such action is needed, the weighmaster, hump conductor, or yardmaster notifies the car retarder operator via the inter-communicating system that the next car over the hump is to be diverted to the hold track. The machine substitutes a special track number for the one previously

called for by the perforated tape. This is done without throwing the tape out of synchronism with the order of the cars. The one number in the machine when the button is pressed is simply passed over. Shop cars, bad order cars, and « hold » cars are similarly handled.

Last minute changes and corrections in car routings are made by operation of other push buttons.

If the clerk makes an error while operating the Teletype transmitter, he can automatically correct it by striking « XX » and then typing the correct number. The decoding apparatus automatically rejects erroneous letters or characters and any single-digit numbers.

Before work began, Portsmouth was a fairly modern hump yard, having been completed in 1928 as a 31-track westbound coal classification yard. In fact, it was among the first in the country to switch and control the speed of cars mechanically.

The recent $ 825 000 modernization program was planned to improve the handling of cars and to render better service.

As President R. H. Smith pointed out at the 1955 Annual Better Service Conference, « The company isn't simply preaching... about the need for more careful car handling, but is spending a lot of money and effort to improve the yard facilities so that what it preaches can be put into practice. »

Besides the introduction of automatic switching, curvature and elevation of track were improved. To assure the assistant yardmaster a better view, the railroad built a glass-enclosed penthouse atop the scale office building. From here, he can watch the entire operation. Using two-way radio, he maintains contact with the four engine crews performing humping and trimming service. Similarly a new loudspeaker system covers the entire yard. This enables the assistant yardmaster to issue instructions to train crews, yard men, and the various offices as changing conditions require.

Today the yard is also better lighted. Four new 90-ft floodlight towers have been constructed, and the low-level lighting system has been enlarged.

Most difficult from an engineering and operating standpoint was the change in yard gradient. The original grade of the classification tracks (1928) was 0.22 %. In recent years, an increasing amount of impact damage was being experienced due to the acceleration of loaded coal cars after they had left the last retarder and as they moved down the classification tracks. This gradient was reduced to 0.15 %.

Close cooperation between departments resulted in near-normal operation of the yard during the extensive renovations. As much as possible, car classification was consolidated on a day-to-day basis, allowing as many as eight tracks to be out of operation at one time.

These improvements have practically eliminated damage to equipment and spillage of coal caused by impacts, and instead of slowing up the yard operation, they have made it possible to reduce the time required for making up a train by an estimated 45 minutes. They give concrete evidence that the Norfolk and Western is doing everything possible to provide the necessary facilities for careful car handling.

[625 .232 (4) & 625 .234 (4)]

Heating of twenty-compartment sleeping cars.

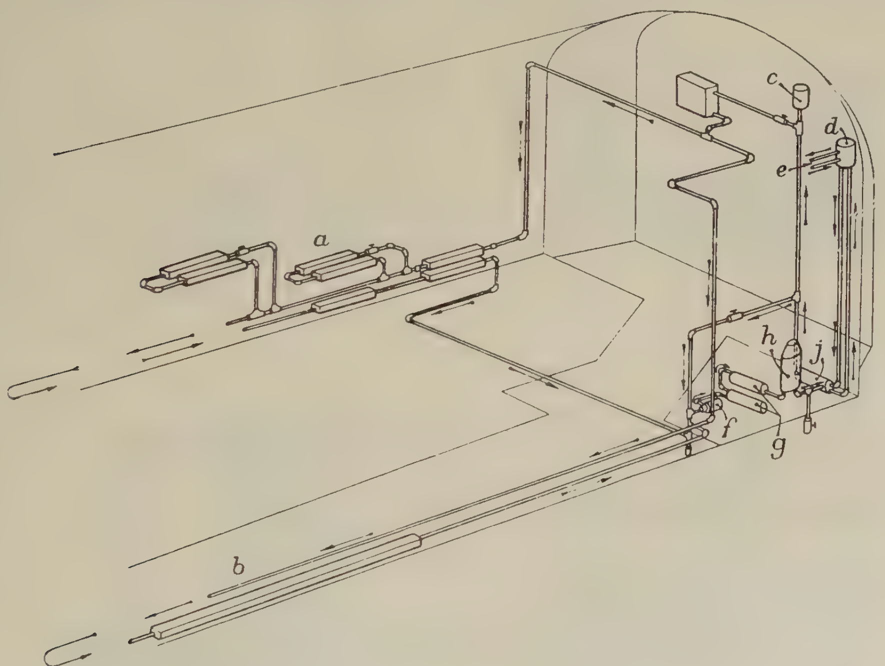
Coal-fired boiler as source of heat for Wagons-lits Company vehicles, with automatic regulation.

(*The Railway Gazette*, December 9. 1955).

Brief particulars of new sleeping cars for the « Compagnie Internationale des Wagons-Lits » with 20 single-berth second class compartments in each car were given in *The Railway Gazette* of September 17, 1954. Cars are heated by means of a coal-fired boiler, the temperature of the ventilated air being thermostatically controlled.

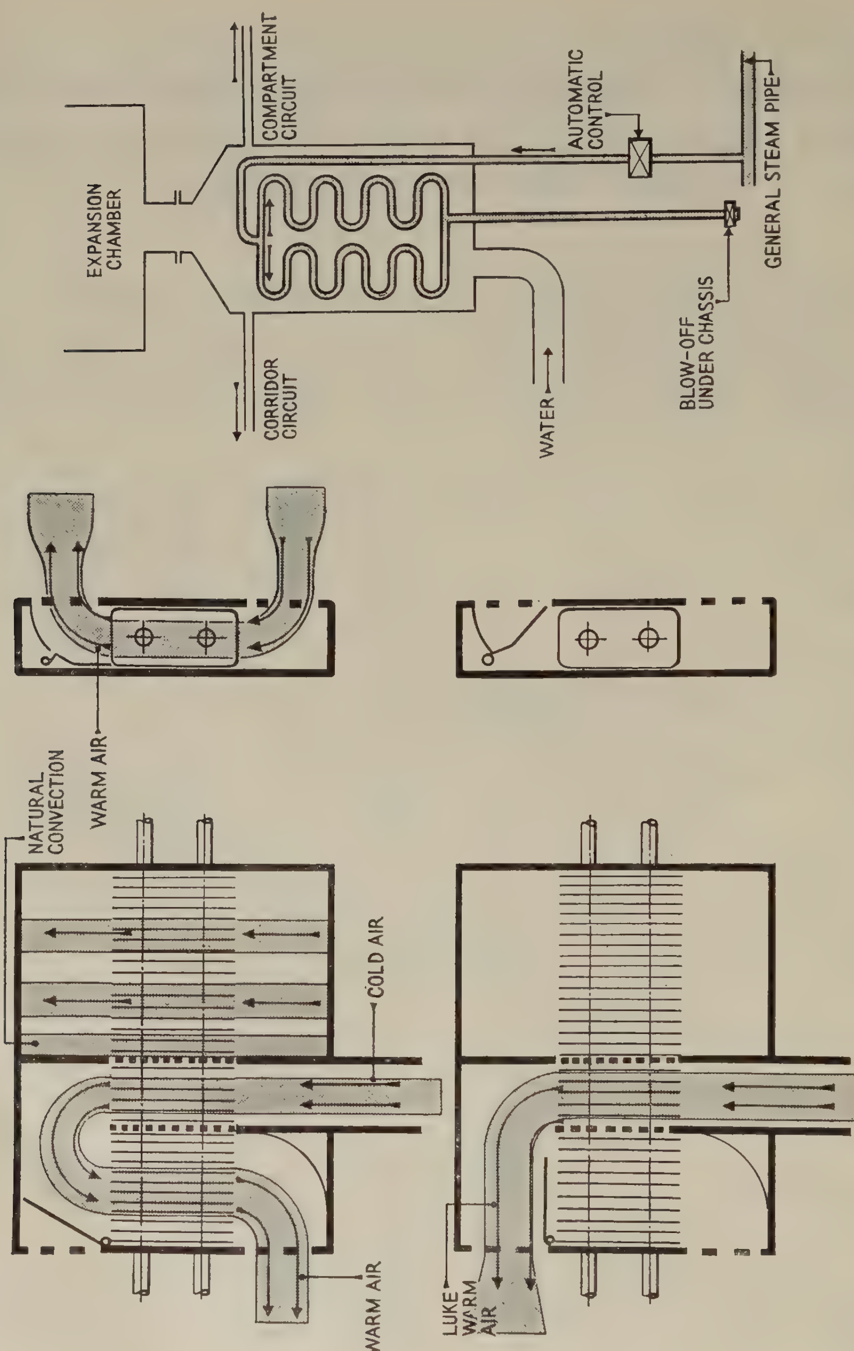
Automatic regulation.

Automatic regulation ensures a constant average temperature of 20° C inside the car. Individual rapid-action regulation of the temperature in each compartment is controlled by the passenger, the adjustment has no effect on the temperature in other compartments.



Diagrammatic layout of the heating system.

a) Compartment circuit.
b) Corridor circuit.
c) Expansion reservoir.
d) Warm water reservoir for toilet.
e) To toilet compartment.
f) Pump.
g) Circulation chamber.
h) Oil-feed boiler.
i) Re-heater.



Layout, showing the convectors, direction of flow, and arrangement of water heater.

The temperature in each compartment is independent of the distance from the boiler. Ventilation is at constant output of 1 300 cu. m. per hour.

The installation comprises mainly a coal-fired boiler, with which is incorporated an electrically-operated Roots blower. There is a hot-water circuit in the corridor, also a hot water circuit feeding the convector in each compartment, and a ventilating device mounted under the roof distributing to the convectors air drawn from the exterior.

The principle of automatic operation consists of blowing through the car a constant hourly volume of ventilated air drawn from the exterior, and heated to the exact temperature of 20° C. If the surfaces of the convectors which heat the ventilating air on the one hand, and the supposedly unventilated cars, on the other hand are carefully calculated, it is only necessary to maintain at a constant level the temperature of the water in the heating circuit, so as to maintain automatically the inside temperature of the car, whatever the variations in outside temperature.

The ventilating air is maintained at a constant temperature of 20° C by means of a single thermostat which electrically controls the motor of the boiler blower; the rate of combustion is thus regulated according to requirements. The convectors in each compartment are made up of a thermically insulated box through which pass two hot water pipes.

The system comprises three separate sections. The first is devoted to the heating of the compartment apart from ventilation, the second to the heating of the ventilating air to 20° C, and the third enables the heat of the air to be controlled by the passenger, by the opening or closing of the grilles. The output of ventilating air remains the same. Several safety devices are included, and an electric switchboard is installed for the conductor.

NEW BOOKS AND PUBLICATIONS.

[**656** .28 (42)]

Lt.-Col. G.R.S. WILSON, C.B.E., Chief Inspecting Officer of Railways, Ministry of Transport and Civil Aviation. — **Report to the Minister of Transport and Civil Aviation upon the Accidents which occurred on the Railways of Great Britain during the year 1954. —** One brochure (6 × 9 $^1/_2$ inches) of 68 pages. — 1955, Her Majesty's Stationary Office, York House, Kingsway, London W.C.2 and 423, Oxford Street, London W.1. (Price : 2 sh. 6 d. net.)

As in previous years, Lt. Col. Wilson's report is divided into three separate chapters for the examination of the statistics and circumstances in which occurred : accidents to trains (derailments, collisions), traffic accidents (due to moving vehicles) and accidents which happened on railway precincts.

In Chapter I, it will be noted that no passenger was killed during 1954. The number of accidents (1 197) is rather higher than in 1953, but less than in 1951 and 1952.

These figures include accidents at level crossings (193) which were 25 fewer than in 1953. The author comments briefly on the cause of the 8 accidents which were the subject of an official enquiry and on certain others due to special and remarkable circumstances.

On the other hand, there was a further reduction in the number of incidents due to the permanent way and stock; the report gives a fairly advantageous comparison of the various reasons for damage occurring compared with previous years.

Chapters II and III also analyse in detail the chief causes of accidents to people other than those due to derailments and collisions.

Under the title *Review of the Year*, the author recapitulates the various accidents and incidents, stating the causes and steps taken or proposed. The latter include in particular improvements in the maintenance of the permanent way and safety equipment.

As far as signalling is concerned, trials in hand which are practically completed, will soon make it possible to decide what system of automatic train control of the warning type is to be introduced. An extension of this method, together with improvements to the signalling and new applications of track circuits and colour light signals form part of the modernisation programme of the British Transport Commission. This is a bold programme intended to overcome as far as possible the consequences of any failure of the human element, which is an ever present factor.

To end, we may add that this programme makes provision for strengthening the permanent way in order to enable it to stand up to speeds of 100 miles an hour (160 km/h).

E. M.

[**385** (08 (492)]

N.V. Nederlandsche Spoorwegen. Jaarverslag 1954 *(Netherlands Railways. Annual Report 1954)*. — One brochure (7 $^7/_8$ × 11 $^3/_4$ inches) of 44 pages with map and illustrations.

The amalgamated Netherlands Railways consist of 3 186 km (1 980 miles) of lines, 1 341 km (833 miles) of which are electrified. During 1954 the extension of Diesel-electric traction still further reduced the part played by steam traction.

The receipts for the year were higher than those for 1953. But labour costs above all, and then maintenance costs also increased and cancelled out this result to a great extent. There remained however a net earning which showed the operating coefficient to be 85 %. Deducting expenditure, the year showed a profit, but a smaller profit than the previous year.

Under the heading : *General considerations,* the report gives a general view of the position of the undertaking and sums up the steps taken or the work decided upon to increase the capacity of the lines and improve the train timetables.

Further details about the latter point are given in the chapter : *Operating.*

Other noteworthy points are given under the headings : *Importance of the traffic, International co-operation, Participations, Staff, Tariffs, Way and Works, Safety, Rolling stock and Workshops.*

On the traffic side, there is an increase both in the case of passengers and goods. The train-kilometres also increased.

For the first time since 1948, the number of employees slightly increased.

The most important change in the internal tariffs was the increasing of the parcels rates. In the case of international services, a few new through rates were introduced in collaboration with the C. E. C. A.

Several sections of lines were equipped with the automatic block with light signals. At the end of the year 358 km (222 miles) of lines were so equipped. New progress were also made as regards increasing safety at level crossings.

The rolling stock position was also improved by the addition of a large number of Diesel-electric locomotives, twin Diesel-electric rakes and freight wagons.

The statistical tables which follow the report, some of which go back as far as 1938, show the activity of the railway during the year in question and its position at the end of the year.

E. M.

[**385** (08 (460)]

RED NACIONAL DE LOS FERROCARRILES ESPAÑOLES. — **Memoria del Consejo de Administración. Ejercicio de 1954** *(Spanish National Railways. — Report of the Administrative Council for the year 1954).* — One volume (8 1/4 × 12 1/4 inches) of 142 pages, illustrated, numerous tables. — 1955, Madrid, Artes Graficas y Editiones, S.A., Rodriguez San Pedro, 32.

The general physiognomy of the year reflects a reduction of traffic, not to any great extent in the case of the passenger traffic, but rather more markedly in the case of freight, especially the fast freight traffic.

On the other hand, expenditure increased owing to wage awards and the increased cost of various materials. The increase made in the rates did not fully meet such increased expenditure, so that the operating coefficient was higher than that for 1953.

Chapter I gives ample details about the evolution of the traffic, the train services and their user. This chapter also includes a comparative examination of the cost of purchases, the labour position (the number of employees is slightly lower) and the social activities of the R. E. N. F. E. for the benefit of its employees.

The economic and financial results are analysed in Chapter II.

The two following chapters are devoted to the further progress made in the constitution and equipment of the system.

Mention is made of important work to the permanent way, the strengthening of bridges, to new stock purchased, and the continuation of the work laid down in the general electrification programme.

The forestry undertakings which supply the R. E. N. F. E. with large quantities of sleepers have continued to give good results.

The chapter devoted to road transport mentions the great increase in competition and the results of interventions by the R. E. N. F. E.

The report ends with the usual tables showing the burdens borne by the railway in the form of taxes and contributions of various kinds.

E. M.

[**385** (09 (494)]

Images C.F.F. *(The C.F.F. Picture Book.)* Published by the Swiss Federal Railways. One brochure ($5\,^1/_2 \times 8\,^1/_4$ inches) of 48 pages, copiously illustrated. — 1955, Zurich, Editions Orell Fussli.

In this age when it is the fashion to impart information by means of pictures, it is not surprising to see a railway making use of this method to bring before the public some of the most remarkable possibilities offered by railway transport.

What strikes the public first of all are the advantages to be obtained from railway travel: speed, comfort, punctuality, and, the chief characteristic of railway travel, practically complete safety. The authors had almost too much material from which to choose in this field, both from the point of view of the organisation as from all the different kinds of modern stock.

In the case of freight traffic, examples of bulk transport, new facilities for parcels traffic, and the door to door services show the importance of the railway in the economy of the country and how it is the invaluable ally of commerce and industry.

Other pictures show the internal life of the railway: the maintenance of the permanent way, the equipment and working of marshalling yards, the battle against snow, and new methods used in the shops.

In a country where 97 % of the lines are electrified, it is easy to understand the value of the great dams and hydro-electric plants, with their corollary, the high tension lines.

We may also mention the innumerable bridges which are so important in Switzerland, and all the safety installations in the stations and on the open line.

If this work is of value in recalling to the public the part played by the railway as a public utility, it also has the merit of calling attention to the unremitting and painstaking efforts which have produced this highly developed instrument.

E. M.

[**385** (08 (59)]

HARRISON C. G., M. I. Mech. E., M. I. Loco E., M.I.I.A., General Manager of the Malayan Railway. — **Federation of Malaya. Malayan Railway Administration Report for the year 1954.** — One brochure ($8\,^1/_4 \times 12\,^1/_2$ inches) of 86 pages, with maps, illustrations and diagrams. — 1955, Kuala Lumpur, Charles Grenier & Son, Ltd.

This report, presented in its usual form, gives details of the operating of the railway as well as its constitution and fixed and movable equipment.

Taken as a whole, the results were satisfactory. The traffic showed a further increase, in the case of both passenger and freight. The attacks of terrorists were again fewer in number with a corresponding reduction in the costs involved and

an improvement in the regularity of the trains.

The last section of the East coast line, which was destroyed by the Japanese during the war, was opened to commercial traffic.

In addition to railway lines the Administration also operates various ports, the most important of which is the port of Swettenham. Here again the traffic is increasing and enlargements are under consideration.

In 1954, in agreement with the Government, the Railway Administration took over the management of the Federation Air Services. These services cover the large centres and remote districts at regular hours. There are many landing fields.

The seventeen chapters, into which the report is divided, deal with the evolution of the receipts and costs, the traffic and services, including the ferry and harbour services.

In another group, the author deals with the position of the permanent way and reports the various innovations in connection with signalling and telecommunications. The rolling stock has been modernised : oil-fired steam locomotives, buying of Diesel locomotives and railcars.

Amongst the administrative questions, which are the subject of other chapters, mention must be made in particular of the health services and the staff. The chief concern of the health services remains the fight against malaria. Statistics show the efficacity of the preventive measures introduced.

The numerous appendices include very detailed figures relating to all the points dealt with in the text of the report.

E. M.

[313 : 385 (65)]

GOUVERNEMENT GÉNÉRAL DE L'ALGÉRIE. DIRECTION DES TRAVAUX PUBLICS ET DES TRANSPORTS. — **Statistique des Chemins de fer d'Algérie au 31 décembre 1954. Intérêt général. Intérêt local. Tramways.** — *(Statistics of the Algerian Railways on the 31st December 1954. Lines of general interest. Lines of local interest. Tramways.)*. — One brochure ($9\ 1/2 \times 11\ 3/4$ inches) of 24 pages. — 1955, Imprimerie Officielle du Gouvernement général de l'Algérie, 7 et 9, rue Trollier, Alger.

The Algerian Railways consist of 4 320 km (2 683 miles) of lines, of which 2 286 km (1 420 miles) are standard gauge and the rest consists of narrow gauge lines of many different gauges. There are also some supplementary lines which extend to 136 km (86 miles).

The tramways (electric tramways, trolleybus and buses) include some 260 km (161 miles) of services operated by the Departmental Management of the Algerian Transport Company and by the Algiers, Oran and Constantine Tramway Companies.

As far as the railways are concerned, the statistical tables show first of all the constitution of the lines and the composition of the rolling stock; then details are given about mileages and consumptions, and the traffic and receipts are analysed.

The financial results of the working show a considerable deficit, corresponding to an operating coefficient of 151 %. Against this must be set the taxes upon the C. F. A. and economies made by the State, and on the other hand the sums allotted to the Pensions Institution for C. F. A. employees.

Comparative tables show the figures for the passenger and freight services, the operating receipts and the general operating results for each year from 1938 to 1954.

As far as the tramways are concerned, the first of the two tables gives the operating results, and the second the position as regards staff, stock and mileages. The financial results have varied; on the whole costs and receipts have balanced, with a slight profit.

E. M.

[**385** .1 (44)]

COULBOIS (P.). — **La situation financiére de la S.N.C.F. et la coordination des transports.** *(The financial position of the S.N.C.F. and the coordination of transport.)*. — One volume (6 1/4 × 9 1/2 inches) of 186 pages. — 1955, Paris (Ve), Librairie Armand Colin, 103, Boulevard Saint-Michel. — Collection « Etudes et Mémoires » published under the supervision of the « Centre d'Etudes Economiques ».

In view of the numerous criticisms the unfortunate financial position of the S. N. C. F. gives rise to, the author has endeavoured to paint an objective picture of the situation and to propose remedies likely to remedy the present deficit within the framework of the co-ordination of transport.

To clarify his report, the author recalls in the opening part of his study the chief outlines of the financial statutes of the S. N. C. F. He examines in particular the regulations governing the sinking funds for the fixed installations and rolling stock, as well as the various contributions from the public finances to the operating account. Finally, he shows the evolution of the deficit during the last ten years.

Then sifting the financial management of the S. N. C. F., the author studies first of all the investments, both from the point of view of their financing as well as their returns, throwing light in particular upon the improvements obtained thanks to the dieselisation and electrification of the system, the speeded up turn round of the stock and the reduced terminal charges.

He then examines the operating costs and receipts. In the case of the former, he discusses in particular, in order to answer criticisms from the noisiest opponents of the S. N. C. F., labour costs, costs due to obligations resulting from being a public services, and those due to running the secondary lines.

In the case of the operating receipts, he studies the fluctuations, analyses the reasons for the chronic deficit shown by the passenger receipts, shows how the S. N. C. F. is trying to remedy this by various improvements, but concludes that it is practically impossible to get rid of this deficit, as the more radical reforms which seem to be necessary might in the end do more harm than good. Then dealing with the problem of freight traffic receipts, he shows how the S. N. C. F. by its tariff policy is trying to defend itself against the increasing competition from other methods of transport in general, and road transport in particular, in spite of the obviously weak position into which it is forced by its statutory obligations compared with other transport undertakings.

The detailed study of the financial management of the S. N. C. F. leads the author to conclude very logically that the greater part of its deficit is due to causes beyond its control and to favour co-ordination of transport on a national scale, a problem which forms the subject of the third part of his study.

Limiting his study to freight transport, the author whilst stressing the difficulty of the question, tries to establish a basis of comparison of costs for different methods of transport, and deals in particular in this connection with the influence of the permanent way.

He then examines the present position as regards obligatory co-ordination in which the fields of activity of the various methods of transport are rigidly defined, and shows how little effective this is.

Finally, he deals with the chances of a tariff co-ordination in which the rates would be so arranged that the free choice of the user which depends upon the comparative rates would always lead to the cheapest form of transport from the point of view of the community being used.

E. M.

[**625** .2]

KERESZTY (P.), General Management of the Hungarian Railways. — **Guiding forces resulting from the support of railway vehicles on their bogies.** — One brochure (6 $^3/_4 \times 9$ $^1/_2$ inches) of 28 pages, with 12 figures, 1955, Budapest. Published in *Acta Technica* of the Hungarian Scientific Academy, Alkotmény U.21.

In this study the author has set himself the task of determining what forces arise on railway vehicles, coaches and wagons, between the body and the bogie on which it rests.

The stresses set up depend upon the method of support and the author considers four solutions, viz. : 1) the centre-plate forming a central bearing and pin; 2) the bogie pin forming a simple guide with lateral runners; 3) and 4) the two Rónai solutions, from the inventor of that name, Gyula RÓNAI, where the body rests on the bogie side frame by means of cylindrical runners (3) or rectangular runners (4) which move between guide rods so arranged that the theoretical centre of rotation lies somewhat to the rear of the bogie centre.

The author sets out the formulae from which it is possible to calculate the forces in the different cases, and gives numerical applications.

It is the Rónai device that the author is mainly concerned with, although he compares the results obtained thereby with those obtained with the bogie pin and centre plate.

As far as this Rónai device is concerned, it appears from the formulae that the stresses depend to a large extent upon the coefficient of friction, and that ample lubrication is necessary if the forces are to be maintained within reasonable limits.

Finally, the stresses are also a function of the position of the theoretical centre of rotation. The formulae show how they vary according to the position of this centre, the selection of which is far from abitrary.

One of the characteristics of the Rónai device is that it makes it unnecessary to have a bogie centre beam.

E. M.

[**385** (08 (44)]

Chemins de fer *(Railways)*. — Special issue of TRANSMONDIA. — *Review of all transport.* (August 1955). — One brochure (7 $\times$ 10 $^1/_2$ inches) of 46 pages, copiously illustrated. — Librairie Chaix, 20, rue Bergère, Paris (IX^e) (Price : 150 French francs).

The periodical « *Rail et Route* » has ceased publication. Its last number, the hundredth, appeared in September 1954. Its readers will not regret their loyalty towards it. For ten years, ever since the liberation, it has kept them informed of all the problems affecting first of all the return to activity of the two methods of transport, and then the thorny question of co-ordination. It is only necessary to glance at the analytical table of the articles which have appeared in this periodical since its first number to appreciate its value and how well it fulfilled the task it had set itself.

In the editorial for the last issue of « *Rail et Route* » under the title « Ten Years of Rail and Road », it called to mind the rapid evolution of these two methods of transport since the liberation. At the same time the birth of a new monthly review « TRANSMONDIA » was announced, and it expressed the hope that its readers would find therein that which they had come to expect of the periodical which was now ceasing publication.

To be accurate *Transmondia* has a wider scope, since it calls itself a « Review of all transport ». It includes articles on transport by rail, by sea, by road and by air, and the programme also includes communications by means of wireless.

Is it possible to forecast that the railway will have its rightful place in this whole, the place which is its due on account of its primary in the transport field? This special issue is most reassuring.

It includes articles dealing with some of the most striking progress made during the last ten years, which have often led to a veritable transformation.

The foreword recalls the great role of the Railway, its influence on the economic and social life of the world, its possibilities, its technical creations and its powerful organisation.

The articles, which follow, deal with such remarkable improvements that they show the railway in a completely new aspect. The search for greater comfort, the speeded up timetables, the study of important international relations are subjects with which the travelling public is very closely concerned.

In the internal life of an undertaking, the equipment of the great marshalling yards is one of the means by which the freight services can be speeded up.

But the great revelation of recent years is the outstanding success of electric traction, especially in the new form of single phase current at industrial frequency. The Review mentions in this connection the developments and astonishing possibilities of this new technique, which was a French invention.

On the other hand, substantial information is given about dieselisation trials in two regions of the S. N. C. F.

One article describes the background for the exploit which led to the amazing speed record of 331 km (206 miles)/h being credited to electric traction.

We must also mention an article devoted to maritime relations between France and Great Britain. This transport which is very flourishing and is assured directly by the railway or by companies connected with the railway, links up the railway systems of the two countries on either side of the Channel very satisfactorily.

E. M.

[**621** .33 (44)]

Journées d'Information sur la Traction électrique par courant monophasé à fréquence industrielle. Lille, 11, 12, 13 et 14 mai 1955. « *La Vie du Rail* », Special Number. — *(Discussion Days on single phase 50 cycle electric traction.* — Lille, 11, 12, 13 and 14th May 1955.). — One brochure (9 $^1/_2 \times 12$ $^1/_4$ inches) of 58 pages, copiously illustrated. — 1955, Paris (IX^e), *La Vie du Rail*, 11, rue de Milan. (Price : 100 French francs.)

This special issue of « *La Vie du Rail* » was intended above all to give information about the essential arrangements of the applications of single phase 50 cycle electric traction made in France.

Paris-Lyons line about which the authors have given a history of electric traction in France. The first chapter is devoted to its beginnings. We see what was done by the main line railways at a time when they were still independent units.

The second chapter deals with the development of D. C. electrification schemes between 1920 and 1947. This was the epoch when lines of general interest were being electrified.

Then came the electrification of the Paris-Lyons line about which the authors give a great many details, which was a most valuable source of experience both as regards the fixed installations and the locomotives.

In « The preparation of future electrifications » we see how profoundly ideas have evolved. Research work and practical trials have prepared the way for 50 cycle single phase traction.

The new scheme took shape in the electrification of the Savoy, then of the Valenciennes-Thionville line. This will be completed by extensions in the North-Eastern Region.

Studies are also in hand regarding services between Paris and the north and the Dole-Vallorbe-(Pontarlier) line.

One article deals with the influence of electrification on the design of the rolling stock (heating and lighting of trains, running and suspension gear, braking).

Some fruitful remarks and reflections are put forward under the title : « Some theories about the evolution of 50 cycle single phase ».

Together with these reports will be found technical details about the supply of current, the contact lines, the substations, the signalling and traction engines. In the case of the latter, the descriptions are accompanied by beautiful plates in colour.

This work will enable readers to appreciate the remarkable characteristics and possibilities of this most recent method of supplying electric locomotives.

E. M.

[**621** .135 .4, **625** .143 .3 & **625** .215 [

1954 — LONDON CONGRESS

NOTE.

relating to Summary 10 of Question 10.

(Wear of rails on curves)

The text of the third paragraph of Summary 10 of Question 10, adopted at the London Congress, during the meeting of the 25th May 1954, is recalled hereafter :

« The higher price of rails with a high proportion of manganese and of bi-metallic » rails, the brittleness of the former particularly in low temperatures, together with heat- » treated rails, however, prevent their use being extended. »

It is pointed out that the rails with a high proportion of manganese, which have been the subject of the discussions during the meetings of the 20th and the 21st May 1954 and of the preceding summary, are rails used on open lines having a manganese content of about 1.5 %.

This summary does not refer therefore to steels with very high proportion of manganese of about 11 to 14 %, such as those used in the manufacture of cast steel crossings.

M. WEISSENBRUCH & Co. Ltd.
Printer to the King

(Manag. Dir.: P. de Weissenbruch,
238, chaussée de Vleurgat, XL)

PRINTED IN BELGIUM

Edit. responsible : P. Ghilain